



CFD General Notation System Mid-Level Library

Document Version 2.4.9

CGNS Version 2.4.4

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1 Introduction

This document outlines a CGNS library designed to ease implementation of CGNS by providing developers with a collection of handy I/O functions. Since knowledge of the ADF (or HDF) core routines is not required to use this library, it greatly facilitates the task of interfacing with CGNS.

The CGNS Mid-Level Library is based on the mappings described in the [SIDS-to-ADF](#) and [SIDS-to-HDF](#) file mapping manuals. It allows reading and writing all of the information described in that manual including grid coordinates, block interfaces, flow solutions, and boundary conditions. Use of the mid-level library functions insures efficient communication between the user application and the internal representation of the CGNS data.

It is assumed that the reader is familiar with the information in the [CGNS Standard Interface Data Structures \(SIDS\)](#), as well as the file mapping manuals. The reader is also strongly encouraged to read the [User's Guide to CGNS](#), which contains coding examples using the Mid-Level Library to write and read simple files containing CGNS databases.

2 General Remarks

2.1 Language

The CGNS Mid-Level Library is written in C, but each function has a Fortran counterpart. All function names start with “cg_”. The Fortran functions have the same name as their C counterpart with the addition of the suffix “_f”.

2.2 Character Strings

All data structure names and labels in CGNS are limited to 32 characters. When reading a file, it is advised to pre-allocate the character string variables to 32 characters in Fortran, and 33 in C (to include the string terminator). Other character strings, such as the CGNS file name or descriptor text, are unlimited in length. The space for unlimited length character strings will be created by the Mid-Level Library; it is then the responsibility of the application to release this space by a call to `cg_free`, described in [Section 10.6](#).

2.3 Error Status

All C functions return an integer value representing the error status. All Fortran functions have an additional parameter, `ier`, which contains the value of the error status. An error status different from zero implies that an error occurred. The error message can be printed using the error handling functions of the CGNS library, described in [Section 5](#). The error codes are coded in the C and Fortran include files `cgnslib.h` and `cgnslib.f.h`.

2.4 Typedefs

Several types of variables are defined using typedefs in the `cgnslib.h` file. These are intended to facilitate the implementation of CGNS in C. These variable types are defined as an enumeration of key words admissible for any variable of these types. The file `cgnslib.h` must be included in any C application programs which use these data types.

In Fortran, the same key words are defined as integer parameters in the include file `cgnslib.f.h`. Such variables should be declared as `integer` in Fortran applications. The file `cgnslib.f.h` must be included in any Fortran application using these key words.

The list of supported values (key words) for each of these variable types (typedef) are:

<code>ZoneType_t</code>	Structured, Unstructured
<code>ElementType_t</code>	NODE, BAR_2, BAR_3, TRI_3, TRI_6, QUAD_4, QUAD_8, QUAD_9, TETRA_4, TETRA_10, PYRA_5, PYRA_14, PENTA_6, PENTA_15, PENTA_18, HEXA_8, HEXA_20, HEXA_27, MIXED, NGON_n
<code>DataType_t</code>	Integer, RealSingle, RealDouble, Character
<code>DataClass_t</code>	Dimensional, NormalizedByDimensional, NormalizedByUnknownDimensional, NondimensionalParameter, DimensionlessConstant

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MassUnits_t	Null, UserDefined, Kilogram, Gram, Slug, PoundMass
LengthUnits_t	Null, UserDefined, Meter, Centimeter, Millimeter, Foot, Inch
TimeUnits_t	Null, UserDefined, Second
TemperatureUnits_t	Null, UserDefined, Kelvin, Celsius, Rankine, Fahrenheit
AngleUnits_t	Null, UserDefined, Degree, Radian
ElectricCurrentUnits_t	Null, UserDefined, Ampere, Abampere, Statampere, Edison, auCurrent
SubstanceAmountUnits_t	Null, UserDefined, Mole, Entities, StandardCubicFoot, StandardCubicMeter
LuminousIntensityUnits_t	Null, UserDefined, Candela, Candle, Carcel, Hefner, Violle
GoverningEquationsType_t	Null, UserDefined, FullPotential, Euler, NSLaminar, NSTurbulent, NSLaminarIncompressible, NSTurbulentIncompressible
ModelType_t	Null, UserDefined, Ideal, VanderWaals, Constant, PowerLaw, SutherlandLaw, ConstantPrandtl, EddyViscosity, ReynoldsStress, ReynoldsStressAlgebraic, Algebraic_BaldwinLomax, Algebraic_CebeciSmith, HalfEquation_JohnsonKing, OneEquation_BaldwinBarth, OneEquation_SpalartAllmaras, TwoEquation_JonesLaunder, TwoEquation_MenterSST, TwoEquation_Wilcox, CaloricallyPerfect, ThermallyPerfect, ConstantDensity, RedlichKwong, Frozen, ThermalEquilib, ThermalNonequilib, ChemicalEquilibCurveFit, ChemicalEquilibMinimization, ChemicalNonequilib, EMElectricField, EMMagneticField, EMConductivity, Voltage, Interpolated, Equilibrium_LinRessler, Chemistry_LinRessler
GridLocation_t	Vertex, IFaceCenter, CellCenter, JFaceCenter, FaceCenter, KFaceCenter, EdgeCenter
GridConnectivityType_t	Overset, Abutting, Abutting1to1
PointSetType_t	PointList, PointRange, PointListDonor, PointRangeDonor, ElementList, ElementRange, CellListDonor
BCType_t	Null, UserDefined, BCAxisymmetricWedge, BCDegenerateLine, BCExtrapolate, BCDegeneratePoint, BCDirichlet, BCFarfield, BCNeumann, BCGeneral, BCInflow, BCOutflow, BCInflowSubsonic, BCOutflowSubsonic, BCInflowSupersonic, BCOutflowSupersonic, BCSymmetryPlane, BCTunnelInflow, BCSymmetryPolar, BCTunnelOutflow, BCWallViscous, BCWall, BCWallViscousHeatFlux, BCWallInviscid, BCWallViscousIsothermal, FamilySpecified

BCDataType_t	Dirichlet, Neumann
RigidGridMotionType_t	Null, UserDefined, ConstantRate, VariableRate
ArbitraryGridMotionType_t	Null, UserDefined, NonDeformingGrid, DeformingGrid
SimulationType_t	TimeAccurate, NonTimeAccurate
WallFunctionType_t	Generic
AreaType_t	BleedArea, CaptureArea
AverageInterfaceType_t	AverageAll, AverageCircumferential, AverageRadial, AverageI, AverageJ, AverageK

Note that these key words need to be written exactly as they appear here, including the use of upper and lower case, to be recognized by the library.

2.5 Acquiring the Software and Documentation

The CGNS Mid-Level Library may be downloaded from SourceForge, at <http://sourceforge.net/projects/cgns>. This manual, as well as the other CGNS documentation, is available in both HTML and PDF format from the CGNS documentation web site, at <http://www.grc.nasa.gov/www/cgns/>.

2.6 Organization of This Manual

The sections that follow describe the Mid-Level Library functions in detail. The first three sections cover opening and closing a CGNS file ([Section 3](#)), accessing a specific node in a CGNS database ([Section 4](#)), and error handling ([Section 5](#)). The remaining sections describe the functions used to read, write, and modify nodes and data in a CGNS database. These sections basically follow the organization used in the “Detailed CGNS Node Descriptions” section of both the [SIDS-to-ADF](#) and [SIDS-to-HDF](#) file mapping manuals.

At the start of each sub-section is a *Node* line, listing the applicable CGNS node label.

Next is a table illustrating the syntax for the Mid-Level Library functions. The C functions are shown in the top half of the table, followed by the corresponding Fortran routines in the bottom half of the table. Input variables are shown in an **upright blue** font, and output variables are shown in a **slanted red** font. For each function, the right-hand column lists the modes (read, write, and/or modify) applicable to that function.

The input and output variables are then listed and defined.

3 Opening and Closing a CGNS File

Functions	Modes
<i>ier</i> = cg_open(char *filename, int mode, int *fn);	r w m
<i>ier</i> = cg_version(int fn, float *version);	r w m
<i>ier</i> = cg_close(int fn);	r w m
call cg_open_f(filename, mode, fn, ier)	r w m
call cg_version_f(fn, version, ier)	r w m
call cg_close_f(fn, ier)	r w m

Input/Output

filename	Name of the CGNS file, including path name if necessary. There is no limit on the length of this character variable. (Input)
mode	Mode used for opening the file. The modes currently supported are MODE_READ, MODE_WRITE, and MODE_MODIFY. (Input)
fn	CGNS file index number. (Input for cg_version and cg_close; output for cg_open)
version	CGNS version number. (Output)
ier	Error status. (Output)

The function `cg_open` must always be the first one called. It opens a CGNS file for reading and/or writing and returns an index number `fn`. The index number serves to identify the CGNS file in subsequent function calls. Several CGNS files can be opened simultaneously. The current limit on the number of files opened at once depends on the platform. On an SGI workstation, this limit is set at 100 (parameter `FOPEN_MAX` in `stdio.h`).

The file can be opened in one of the following modes:

MODE_READ	Read only mode.
MODE_WRITE	Write only mode.
MODE_MODIFY	Reading and/or writing is allowed.

When the file is opened, if no `CGNSLibraryVersion_t` node is found, a default value of 1.05 is assumed for the CGNS version number. Note that this corresponds to an old version of the CGNS standard, that doesn't include many data structures supported by the current standard.

The function `cg_close` must always be the last one called. It closes the CGNS file designated by the index number `fn` and frees the memory where the CGNS data was kept. When a file is opened for writing, `cg_close` writes all the CGNS data in memory onto disk prior to closing the file. Consequently, if is omitted, the CGNS file is not written properly.

In order to reduce memory usage and improve execution speed, large arrays such as grid coordinates or flow solutions are not actually stored in memory. Instead, only their ADF (or HDF) ID numbers are kept in memory for future reference. When a CGNS file is open in writing mode, large arrays passed to the library are immediately written into the CGNS file, directly under the root node. When the file is closed, these arrays are moved to their appropriate location in the CGNS tree.

4 Navigating a CGNS File

4.1 Accessing a Node

Functions	Modes
<i>ier</i> = cg_goto(int fn, int B, ..., "end");	r w m
call cg_goto_f(fn, B, <i>ier</i> , ..., 'end')	r w m

Input/Output

- fn** CGNS file index number. (Input)
- B** Base index number, where $1 \leq B \leq \text{nbases}$. (Input)
- ...** Variable argument list used to specify the path to a node. It is composed of an unlimited list of pair-arguments. Each pair-argument takes the form `CGNS_NodeLabel, NodeIndex`. An example is `Zone_t, ZoneIndex`.
There is one exception to this rule. When accessing a `BCData_t` node, the index must be set to either `Dirichlet` or `Neumann` since only these two types are allowed. (Note that `Dirichlet` and `Neumann` are defined in the include files `cgnslib.h` and `cgnslib.f.h`). See the example below. (Input)
- end** The character string "end" (or 'end' for the Fortran function) must be the last argument. It is used to indicate the end of the argument list. (Input)
- ier** Error status. The possible values, with the corresponding C names (or Fortran parameters) defined in `cgnslib.h` (or `cgnslib.f.h`) are listed below.

Value	Name/Parameter
0	CG_OK
1	CG_ERROR
2	CG_NODE_NOT_FOUND
3	CG_INCORRECT_PATH

For non-zero values, an error message may be printed using `cg_error_print()`, as described in [Section 5](#). (Output)

This function allows access to any parent-type nodes in a CGNS file. A parent-type node is one that can have children. Nodes that cannot have children, like `Descriptor_t`, are not supported by this function.

Example

```
ier = cg_goto(fn, B, "Zone_t", Z, "FlowSolution_t", F, "end");
call cg_goto_f(fn, B, ier, 'Zone_t', Z, 'GasModel_t', 1, 'DataArray_t',
               A, 'end')
call cg_goto_f(fn, B, 'Zone_t', Z, 'ZoneBC_t', 1, 'BC_t', BC,
               'BCDataSet_t', S, 'BCData_t', Dirichlet)
```

4.2 Deleting a Node

Functions	Modes
<i>ier</i> = cg_delete_node(char *NodeName);	- - m
call cg_delete_node_f(NodeName, <i>ier</i>)	- - m

Input/Output

NodeName Name of the child to be deleted. (*Input*)

ier Error status. (*Output*)

The function `cg_delete_node` is used in conjunction with `cg_goto`. Once positioned at a parent node with `cg_goto`, a child of this node can be deleted with `cg_delete_node`. This function requires a single argument, `NodeName`, which is the name of the child to be deleted.

Since the highest level that can be pointed to with `cg_goto` is a base node for a CGNS database (`CGNSBase_t`), the highest-level nodes that can be deleted are the children of a `CGNSBase_t` node. In other words, nodes located directly under the ADF (or HDF) root node (`CGNSBase_t` and `CGNSLibraryVersion_t`) can not be deleted with `cg_delete`.

A few other nodes are not allowed to be deleted from the database because these are required nodes as defined by the SIDS, and deleting them would make the file non-CGNS compliant. These are:

- Under `Zone_t`: `ZoneType`
- Under `GridConnectivity1to1_t`: `PointRange`, `PointRangeDonor`, `Transform`
- Under `OverSetHoles_t`: `PointList` and any `IndexRange_t`
- Under `GridConnectivity_t`: `PointRange`, `PointList`, `CellListDonor`, `PointListDonor`
- Under `BC_t`: `PointList`, `PointRange`
- Under `GeometryReference_t`: `GeometryFile`, `GeometryFormat`
- Under `Elements_t`: `ElementRange`, `ElementConnectivity`
- Under `Gravity_t`: `GravityVector`
- Under `Axisymmetry_t`: `AxisymmetryReferencePoint`, `AxisymmetryAxisVector`
- Under `RotatingCoordinates_t`: `RotationCenter`, `RotationRateVector`
- Under `Periodic_t`: `RotationCenter`, `RotationAngle`, `Translation`
- Under `AverageInterface_t`: `AverageInterfaceType`
- Under `WallFunction_t`: `WallFunctionType`
- Under `Area_t`: `AreaType`, `SurfaceArea`, `RegionName`

When a child node is deleted, both the database and the file on disk are updated to remove the node. One must be careful not to delete a node from within a loop of that node type. For example, if the number of zones below a `CGNSBase_t` node is `nzones`, a zone should never be deleted from within a zone loop! By deleting a zone, the total number of zones (`nzones`) changes, as well as the zone indexing. Suppose for example that `nzones` is 5, and that the third zone is deleted. After calling `cg_delete_node`, `nzones` is changed to 4, and the zones originally indexed 4 and 5 are now indexed 3 and 4.

5 Error Handling

Functions	Modes
<code>error_message = char *cg_get_error();</code>	r w m
<code>void cg_error_exit();</code>	r w m
<code>void cg_error_print();</code>	r w m
<code>call cg_get_error_f(error_message)</code>	r w m
<code>call cg_error_exit_f()</code>	r w m
<code>call cg_error_print_f()</code>	r w m

If an error occurs during the execution of a CGNS library function, signified by a non-zero value of the error status variable `ier`, an error message may be retrieved using the function `cg_get_error`. The function `cg_error_exit` may then be used to print the error message and stop the execution of the program. Alternatively, `cg_error_print` may be used to print the error message and continue execution of the program.

6 Structural Nodes

6.1 CGNS Base Information

Node: CGNSBase_t

Functions	Modes
<i>ier</i> = cg_base_write(int <i>fn</i> , char * <i>basename</i> , int <i>cell_dim</i> , int <i>phys_dim</i> , int * <i>B</i>);	- w m
<i>ier</i> = cg_nbases(int <i>fn</i> , int * <i>nbases</i>);	r - m
<i>ier</i> = cg_base_read(int <i>fn</i> , int <i>B</i> , char * <i>basename</i> , int * <i>cell_dim</i> , int * <i>phys_dim</i>);	r - m
call cg_base_write_f(<i>fn</i> , <i>basename</i> , <i>cell_dim</i> , <i>phys_dim</i> , <i>B</i> , <i>ier</i>)	- w m
call cg_nbases_f(<i>fn</i> , <i>nbases</i> , <i>ier</i>)	r - m
call cg_base_read_f(<i>fn</i> , <i>B</i> , <i>basename</i> , <i>cell_dim</i> , <i>phys_dim</i> , <i>ier</i>)	r - m

Input/Output

<i>fn</i>	CGNS file index number. (Input)
<i>B</i>	Base index number, where $1 \leq B \leq \text{nbases}$. (Input for cg_base_read; output for cg_base_write)
<i>nbases</i>	Number of bases present in the CGNS file <i>fn</i> . (Output)
<i>basename</i>	Name of the base. (Input for cg_base_write; output for cg_base_read)
<i>cell_dim</i>	Dimension of the cells; 3 for volume cells, 2 for surface cells. (Input for cg_base_write; output for cg_base_read)
<i>phys_dim</i>	Number of coordinates required to define a vector in the field. (Input for cg_base_write; output for cg_base_read)
<i>ier</i>	Error status. (Output)

6.2 Zone Information

Node: Zone_t

Functions	Modes
<i>ier</i> = cg_zone_write(int <i>fn</i> , int <i>B</i> , char * <i>zonename</i> , int * <i>size</i> , ZoneType_t <i>zonetype</i> , int * <i>Z</i>);	- w m
<i>ier</i> = cg_nzones(int <i>fn</i> , int <i>B</i> , int * <i>nzones</i>);	r - m
<i>ier</i> = cg_zone_read(int <i>fn</i> , int <i>B</i> , int <i>Z</i> , char * <i>zonename</i> , int * <i>size</i>);	r - m
<i>ier</i> = cg_zone_type(int <i>fn</i> , int <i>B</i> , int <i>Z</i> , ZoneType_t * <i>zonetype</i>);	r - m
call cg_zone_write_f(<i>fn</i> , <i>B</i> , <i>zonename</i> , <i>size</i> , <i>zonetype</i> , <i>Z</i> , <i>ier</i>)	- w m
call cg_nzones_f(<i>fn</i> , <i>B</i> , <i>nzones</i> , <i>ier</i>)	r - m
call cg_zone_read_f(<i>fn</i> , <i>B</i> , <i>Z</i> , <i>zonename</i> , <i>size</i> , <i>ier</i>)	r - m
call cg_zone_type_f(<i>fn</i> , <i>B</i> , <i>Z</i> , <i>zonetype</i> , <i>ier</i>)	r - m

Input/Output

fn	CGNS file index number. (Input)										
B	Base index number, where $1 \leq B \leq \text{nbases}$. (Input)										
Z	Zone index number, where $1 \leq Z \leq \text{nzones}$. (Input for <code>cg_zone_read</code> , <code>cg_zone_type</code> ; output for <code>cg_zone_write</code>)										
nzones	Number of zones present in base B. (Output)										
zonename	Name of the zone. (Input for <code>cg_zone_write</code> ; output for <code>cg_zone_read</code>)										
size	<p>Number of vertices, cells, and boundary vertices in each (<i>index</i>)-dimension.</p> <p>Note that for unstructured grids, the number of cells is the number of highest order elements. Thus, in three dimensions it's the number of 3-D cells, and in two dimensions it's the number of 2-D cells.</p> <p>Also for unstructured grids, if the nodes are sorted between internal nodes and boundary nodes, the optional parameter <code>NBoundVertex</code> must be set equal to the number of boundary nodes. By default, <code>NBoundVertex</code> equals zero, meaning that the nodes are unsorted.</p> <p>Note that a non-zero value for <code>NBoundVertex</code> only applies to unstructured grids. For structured grids, the <code>NBoundVertex</code> parameter always equals 0 in all directions.</p> <table> <tr> <th><i>Mesh Type</i></th><th><i>Size</i></th></tr> <tr> <td>3D structured</td><td> <code>NVertexI</code>, <code>NVertexJ</code>, <code>NVertexK</code> <code>NCellI</code>, <code>NCellJ</code>, <code>NCellK</code> <code>NBoundVertexI</code> = 0, <code>NBoundVertexJ</code> = 0, <code>NBoundVertexK</code> </td></tr> <tr> <td>2D structured</td><td> <code>NVertexI</code>, <code>NVertexJ</code> <code>NCellI</code>, <code>NCellJ</code> <code>NBoundVertexI</code> = 0, <code>NBoundVertexJ</code> = 0 </td></tr> <tr> <td>3D unstructured</td><td><code>NVertex</code>, <code>NCell13D</code>, <code>NBoundVertex</code></td></tr> <tr> <td>2D unstructured</td><td><code>NVertex</code>, <code>NCell12D</code>, <code>NBoundVertex</code></td></tr> </table> <p>(Input for <code>cg_zone_write</code>; output for <code>cg_zone_read</code>)</p>	<i>Mesh Type</i>	<i>Size</i>	3D structured	<code>NVertexI</code> , <code>NVertexJ</code> , <code>NVertexK</code> <code>NCellI</code> , <code>NCellJ</code> , <code>NCellK</code> <code>NBoundVertexI</code> = 0, <code>NBoundVertexJ</code> = 0, <code>NBoundVertexK</code>	2D structured	<code>NVertexI</code> , <code>NVertexJ</code> <code>NCellI</code> , <code>NCellJ</code> <code>NBoundVertexI</code> = 0, <code>NBoundVertexJ</code> = 0	3D unstructured	<code>NVertex</code> , <code>NCell13D</code> , <code>NBoundVertex</code>	2D unstructured	<code>NVertex</code> , <code>NCell12D</code> , <code>NBoundVertex</code>
<i>Mesh Type</i>	<i>Size</i>										
3D structured	<code>NVertexI</code> , <code>NVertexJ</code> , <code>NVertexK</code> <code>NCellI</code> , <code>NCellJ</code> , <code>NCellK</code> <code>NBoundVertexI</code> = 0, <code>NBoundVertexJ</code> = 0, <code>NBoundVertexK</code>										
2D structured	<code>NVertexI</code> , <code>NVertexJ</code> <code>NCellI</code> , <code>NCellJ</code> <code>NBoundVertexI</code> = 0, <code>NBoundVertexJ</code> = 0										
3D unstructured	<code>NVertex</code> , <code>NCell13D</code> , <code>NBoundVertex</code>										
2D unstructured	<code>NVertex</code> , <code>NCell12D</code> , <code>NBoundVertex</code>										
zonetype	Type of the zone. The admissible types are <code>Structured</code> and <code>Unstructured</code> . (Input for <code>cg_zone_write</code> ; output for <code>cg_zone_type</code>)										
ier	Error status. (Output)										

Note that the zones are sorted alphanumerically to insure that they can always be retrieved in the same order (for the same model).

6.3 Simulation Type

Node: `SimulationType_t`

Functions	Modes
<i>ier</i> = cg_simulation_type_write(int fn, int B, SimulationType_t SimulationType);	- w m
<i>ier</i> = cg_simulation_type_read(int fn, int B, SimulationType_t SimulationType);	r - m
call cg_simulation_type_write_f(fn, B, SimulationType, <i>ier</i>)	- w m
call cg_simulation_type_read_f(fn, B, SimulationType, <i>ier</i>)	r - m

Input/Output

fn	CGNS file index number. (Input)
B	Base index number, where $1 \leq B \leq \text{nbases}$. (Input)
SimulationType	Type of simulation. Valid types are Null, UserDefined, TimeAccurate, and NonTimeAccurate. (Input for cg_simulation_type_write; output for cg_simulation_type_read)
ier	Error status. (Output)

7 Descriptors

7.1 Descriptive Text

Node: Descriptor_t

Functions	Modes
<i>ier</i> = cg_descriptor_write(char *name, char *text);	- w m
<i>ier</i> = cg_ndescriptors(int *ndescriptors);	r - m
<i>ier</i> = cg_descriptor_read(int D, char *name, char **text);	r - m
call cg_descriptor_write_f(name, text, ier)	- w m
call cg_ndescriptors_f(ndescriptors, ier)	r - m
call cg_descriptor_size_f(D, size, ier)	r - m
call cg_descriptor_read_f(D, name, text, ier)	r - m

Input/Output

ndescriptors	Number of Descriptor_t nodes under the current node. (<i>Output</i>)
D	Descriptor index number, where $1 \leq D \leq \text{ndescriptors}$. (<i>Input</i>)
name	Name of the Descriptor_t node. (<i>Input</i> for cg_descriptor_write; <i>output</i> for cg_descriptor_read)
text	Description held in the Descriptor_t node. (<i>Input</i> for cg_descriptor_write; <i>output</i> for cg_descriptor_read)
size	Size of the descriptor data (Fortran interface only). (<i>Output</i>)
ier	Error status. (<i>Output</i>)

Note that with cg_descriptor_read the memory for the descriptor character string, text, will be allocated by the Mid-Level Library. The application code is responsible for releasing this memory when it is no longer needed by calling cg_free(text), described in [Section 10.6](#).

7.2 Ordinal Value

Node: Ordinal_t

Functions	Modes
<i>ier</i> = cg_ordinal_write(int Ordinal);	- w m
<i>ier</i> = cg_ordinal_read(int *Ordinal);	r - m
call cg_ordinal_write_f(Ordinal, ier)	- w m
call cg_ordinal_read_f(Ordinal, ier)	r - m

Input/Output

Ordinal	Any integer value. (<i>Input</i> for cg_ordinal_write; <i>output</i> for cg_ordinal_read)
ier	Error status. (<i>Output</i>)

8 Physical Data

8.1 Data Arrays

Node: DataArray_t

Functions	Modes
<i>ier</i> = cg_array_write(char *ArrayName, DataType_t DataType, int DataDimension, int *DimensionVector, void *Data);	- w m
<i>ier</i> = cg_narrays(int *narrays);	r - m
<i>ier</i> = cg_array_info(int A, char *ArrayName, DataType_t *DataType, int *DataDimension, int *DimensionVector);	r - m
<i>ier</i> = cg_array_read(int A, void *Data);	r - m
<i>ier</i> = cg_array_read_as(int A, DataType_t DataType, void *Data);	r - m
call cg_array_write_f(ArrayName, DataType, DataDimension, DimensionVector, Data, <i>ier</i>)	- w m
call cg_narrays_f(narrays, <i>ier</i>)	r - m
call cg_array_info_f(A, ArrayName, DataType, DataDimension, DimensionVector, <i>ier</i>)	r - m
call cg_array_read_f(A, Data, <i>ier</i>)	r - m
call cg_array_read_as_f(A, DataType, Data, <i>ier</i>)	r - m

Input/Output

narrays	Number of DataArray_t nodes under the current node. (<i>Output</i>)
A	Data array index, where $1 \leq A \leq \text{narrays}$. (<i>Input</i>)
ArrayName	Name of the DataArray_t node. (<i>Input</i> for cg_array_write; <i>output</i> for cg_array_info)
DataType	Type of data held in the DataArray_t node. The admissible types are Integer, RealSingle, RealDouble, and Character. (<i>Input</i> for cg_array_write, cg_array_read_as; <i>output</i> for cg_array_info)
DataDimension	Number of dimensions. (<i>Input</i> for cg_array_write; <i>output</i> for cg_array_info)
DimensionVector	Number of data elements in each dimension. (<i>Input</i> for cg_array_write; <i>output</i> for cg_array_info)
Data	The data array. (<i>Input</i> for cg_array_write; <i>output</i> for cg_array_read, cg_array_read_as)
ier	Error status. (<i>Output</i>)

8.2 Data Class

Node: DataClass_t

Functions	Modes
<i>ier</i> = cg_dataclass_write(DataClass_t dataclass);	- w m
<i>ier</i> = cg_dataclass_read(DataClass_t *dataclass);	r - m
call cg_dataclass_write_f(dataclass, <i>ier</i>)	- w m
call cg_dataclass_read_f(dataclass, <i>ier</i>)	r - m

Input/Output

- dataclass** Data class for the nodes at this level. See below for the data classes currently supported in CGNS. (**Input** for cg_dataclass_write; **output** for cg_dataclass_read)
- ier** Error status. (**Output**)

The data classes currently supported in CGNS are:

- | | |
|--------------------------------|---|
| Dimensional | Regular dimensional data. |
| NormalizedByDimensional | Nondimensional data that is normalized by dimensional reference quantities. |
| NormalizedByUnknownDimensional | All fields and reference data are nondimensional. |
| NondimensionalParameter | Nondimensional parameters such as Mach number and lift coefficient. |
| DimensionlessConstant | Constant such as π . |

These classes are declared within typedef DataClass_t in *cgnslib.h*, and as parameters in *cgnslib-f.h*.

8.3 Data Conversion Factors

Node: DataConversion_t

Functions	Modes
<i>ier</i> = cg_conversion_write(DataType_t DataType, void *ConversionFactors);	- w m
<i>ier</i> = cg_conversion_info(DataType_t *DataType);	r - m
<i>ier</i> = cg_conversion_read(void *ConversionFactors);	r - m
call cg_conversion_write_f(DataType, ConversionFactors, <i>ier</i>)	- w m
call cg_conversion_info_f(DataType, <i>ier</i>)	r - m
call cg_conversion_read_f(ConversionFactors, <i>ier</i>)	r - m

Input/Output

DataType	Data type in which the conversion factors are recorded. Admissible data types for conversion factors are RealSingle and RealDouble. (<i>Input</i> for cg_conversion_write; <i>output</i> for cg_conversion_info)
ConversionFactors	Two-element array containing the scaling and offset factors. (<i>Input</i> for cg_conversion_write; <i>output</i> for cg_conversion_read)
ier	Error status. (<i>Output</i>)

The DataConversion_t data structure contains factors to convert the nondimensional data to “raw” dimensional data. The scaling and offset factors are contained in the two-element array ConversionFactors. In pseudo-Fortran, the conversion process is as follows:

```

ConversionScale = ConversionFactors(1)
ConversionOffset = ConversionFactors(2)
Data(raw) = Data(nondimensional)*ConversionScale + ConversionOffset

```

8.4 Dimensional Units

Node: DimensionalUnits_t

Functions	Modes
<i>ier</i> = cg_units_write(MassUnits_t mass, LengthUnits_t length, TimeUnits_t time, TemperatureUnits_t temperature, AngleUnits_t angle);	- w m
<i>ier</i> = cg_unitsfull_write(MassUnits_t mass, LengthUnits_t length, TimeUnits_t time, TemperatureUnits_t temperature, AngleUnits_t angle, ElectricCurrentUnits_t current, SubstanceAmountUnits_t amount, LuminousIntensityUnits_t intensity);	- w m
<i>ier</i> = cg_nunits(int *nunits);	r - m
<i>ier</i> = cg_units_read(MassUnits_t *mass, LengthUnits_t *length, TimeUnits_t *time, TemperatureUnits_t *temperature, AngleUnits_t *angle);	r - m
<i>ier</i> = cg_unitsfull_read(MassUnits_t *mass, LengthUnits_t *length, TimeUnits_t *time, TemperatureUnits_t *temperature, AngleUnits_t *angle, ElectricCurrentUnits_t *current, SubstanceAmountUnits_t *amount, LuminousIntensityUnits_t *intensity);	r - m
call cg_units_write_f(mass, length, time, temperature, angle, <i>ier</i>)	- w m
call cg_unitsfull_write_f(mass, length, time, temperature, angle, current, amount, intensity, <i>ier</i>)	- w m
call cg_nunits_f(int *nunits)	r - m
call cg_units_read(mass, length, time, temperature, angle, <i>ier</i>)	r - m
call cg_unitsfull_read_f(mass, length, time, temperature, angle, current, amount, intensity, <i>ier</i>)	r - m

Input/Output

mass	Mass units. Admissible values are Null, UserDefined, Kilogram, Gram, Slug, and PoundMass. (Input for cg_units_write, cg_unitsfull_write; output for cg_units_read, cg_unitsfull_read)
length	Length units. Admissible values are Null, UserDefined, Meter, Centimeter, Millimeter, Foot, and Inch. (Input for cg_units_write, cg_unitsfull_write; output for cg_units_read, cg_unitsfull_read)
time	Time units. Admissible values are Null, UserDefined, and Second. (Input for cg_units_write, cg_unitsfull_write; output for cg_units_read, cg_unitsfull_read)
temperature	Temperature units. Admissible values are Null, UserDefined, Kelvin, Celsius, Rankine, and Fahrenheit. (Input for cg_units_write, cg_unitsfull_write; output for cg_units_read, cg_unitsfull_read)
angle	Angle units. Admissible values are Null, UserDefined, Degree, and Radian. (Input for cg_units_write, cg_unitsfull_write; output for cg_units_read, cg_unitsfull_read)
current	Electric current units. Admissible values are Null, UserDefined, Ampere, Abampere, Statampere, Edison, and auCurrent. (Input for cg_unitsfull_write; output for cg_unitsfull_read)
amount	Substance amount units. Admissible values are Null, UserDefined, Mole, Entities, StandardCubicFoot, and StandardCubicMeter. (Input for cg_unitsfull_write; output for cg_unitsfull_read)
intensity	Luminous intensity units. Admissible values are Null, UserDefined, Candela, Candle, Carcel, Hefner, and Violle. (Input for cg_unitsfull_write; output for cg_unitsfull_read)
nunits	Number of units used in the file (i.e., either 5 or 8). (Output)
ier	Error status. (Output)

The supported units are declared within typedefs in *cgnslib.h* and as parameters in *cgnslib.f.h*.

When reading units data, either `cg_units_read` or `cg_unitsfull_read` may be used, regardless of the number of units used in the file. If `cg_unitsfull_read` is used, but only five units are used in the file, the returned values of `current`, `amount`, and `intensity` will be Null.

8.5 Dimensional Exponents

Node: DimensionalExponents_t

Functions	Modes
<i>ier</i> = cg_exponents_write(DataType_t DataType, void *exponents);	- w m
<i>ier</i> = cg_expfull_write(DataType_t DataType, void *exponents);	- w m
<i>ier</i> = cg_nexponents(int *nexponents);	r - m
<i>ier</i> = cg_exponents_info(DataType_t *DataType);	r - m
<i>ier</i> = cg_exponents_read(void *exponents);	r - m
<i>ier</i> = cg_expfull_read(void *exponents);	r - m
call cg_exponents_write_f(DataType, exponents, <i>ier</i>)	- w m
call cg_expfull_write_f(DataType, exponents, <i>ier</i>)	- w m
call cg_nexponents_f(<i>nexponents</i> , <i>ier</i>)	r - m
call cg_exponents_info_f(DataType, <i>ier</i>)	r - m
call cg_exponents_read_f(<i>exponents</i> , <i>ier</i>)	r - m
call cg_expfull_read_f(<i>exponents</i> , <i>ier</i>)	r - m

Input/Output

DataType	Data type in which the exponents are recorded. Admissible data types for the exponents are RealSingle and RealDouble. (Input for cg_exponents_write; <i>output</i> for cg_exponents_info)
exponents	Exponents for the dimensional units for mass, length, time, temperature, angle, electric current, substance amount, and luminous intensity, in that order. (Input for cg_exponents_write, cg_expfull_write; <i>output</i> for cg_exponents_read, cg_expfull_read)
nexponents	Number of exponents used in the file (i.e., either 5 or 8). (<i>Output</i>)
ier	Error status. (<i>Output</i>)

When reading exponent data, either `cg_exponents_read` or `cg_expfull_read` may be used, regardless of the number of exponents used in the file. If `cg_exponents_read` is used, but all eight exponents are used in the file, only the first five exponents are returned. If `cg_expfull_read` is used, but only five exponents are used in the file, the returned values of the exponents for electric current, substance amount, and luminous intensity will be zero.

9 Location and Position

9.1 Grid Location

Node: GridLocation_t

Functions	Modes
<i>ier</i> = cg_gridlocation_write(GridLocation_t GridLocation);	- w m
<i>ier</i> = cg_gridlocation_read(GridLocation_t *GridLocation);	r - m
call cg_gridlocation_write_f(GridLocation, <i>ier</i>)	- w m
call cg_gridlocation_read_f(GridLocation, <i>ier</i>)	r - m

Input/Output

GridLocation	Location in the grid. The admissible locations are Null, UserDefined, Vertex, CellCenter, FaceCenter, IFaceCenter, JFaceCenter, KFaceCenter, and EdgeCenter. (Input for cg_gridlocation_write; <i>output</i> for cg_gridlocation_read)
ier	Error status. (<i>Output</i>)

9.2 Point Sets

Node: IndexArray_t, IndexRange_t

Functions	Modes
<i>ier</i> = cg_ptset_write(PointSetType_t *ptset_type, int npnts, int *pnts);	- w m
<i>ier</i> = cg_ptset_info(PointSetType_t *ptset_type, int *npnts);	r - m
<i>ier</i> = cg_ptset_read(int *pnts);	r - m
call cg_ptset_write_f(ptset_type, npnts, pnts, <i>ier</i>)	- w m
call cg_ptset_info_f(ptset_type, npnts, <i>ier</i>)	r - m
call cg_ptset_read_f(pnts, <i>ier</i>)	r - m

Input/Output

ptset_type	The point set type; either PointRange for a range of points or cells, or PointList for a list of discrete points or cells. (Input for cg_ptset_write; <i>output</i> for cg_ptset_info)
npnts	The number of points or cells in the point set. For a point set type of PointRange, npnts is always two. For a point set type of PointList, npnts is the number of points or cells in the list. (Input for cg_ptset_write; <i>output</i> for cg_ptset_info)
pnts	The array of point or cell indices defining the point set. There should be npnts values, each of dimension IndexDimension (i.e., 1 for unstructured grids, and 2 or 3 for structured grids with 2-D or 3-D elements, respectively). (Input for cg_ptset_write; <i>output</i> for cg_ptset_read)

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`ier` Error status. (*Output*)

These functions may be used to write and read point set data (i.e., an `IndexArray_t` node named `PointList`, or an `IndexRange_t` node named `PointRange`). They are only applicable at nodes that are descendents of a `Zone_t` node.

9.3 Rind Layers

Node: `Rind_t`

Functions	Modes
<code>ier = cg_rind_write(int *RindData);</code>	- w m
<code>ier = cg_rind_read(int *RindData);</code>	r - m
<code>call cg_rind_write_f(RindData, ier)</code>	- w m
<code>call cg_rind_read_f(RindData, ier)</code>	r - m

Input/*Output*

`RindData` Number of rind layers for each computational direction (structured grid) or number of rind points or elements (unstructured grid). (*Input* for `cg_rind_write`; *output* for `cg_rind_read`)

`ier` Error status. (*Output*)

When writing rind data for elements, `cg_section_write` must be called first (see [Section 11.2](#)), followed by `cg_goto` ([Section 4](#)) to access the `Elements_t` node, and then `cg_rind_write`.

10 Auxiliary Data

10.1 Reference State

Node: ReferenceState_t

Functions	Modes
<i>ier</i> = cg_state_write(char *StateDescription);	- w m
<i>ier</i> = cg_state_read(char **StateDescription);	r - m
call cg_state_write_f(StateDescription, <i>ier</i>)	- w m
call cg_state_size_f(Size, <i>ier</i>)	r - m
call cg_state_read_f(StateDescription, <i>ier</i>)	r - m

Input/Output

StateDescription	Text description of reference state. (<i>Input</i> for cg_state_write; <i>output</i> for cg_state_read)
Size	Number of characters in the StateDescription string (Fortran interface only). (<i>Output</i>)
ier	Error status. (<i>Output</i>)

The function `cg_state_write` creates the `ReferenceState_t` node and must be called even if `StateDescription` is undefined (i.e., a blank string). The descriptors, data arrays, data class, and dimensional units characterizing the `ReferenceState_t` data structure may be added to this data structure after its creation.

The function `cg_state_read` reads the `StateDescription` of the local `ReferenceState_t` node. If `StateDescription` is undefined in the CGNS database, this function returns a null string. If `StateDescription` exists, the library will allocate the space to store the description string, and return the description string to the application. It is the responsibility of the application to free this space when it is no longer needed by a call to `cg_free(StateDescription)`, described in [Section 10.6](#).

10.2 Gravity

Node: Gravity_t

Functions	Modes
<i>ier</i> = cg_gravity_write(int fn, int B, float *GravityVector);	- w m
<i>ier</i> = cg_gravity_read(int fn, int B, float *GravityVector);	r - m
call cg_gravity_write_f(fn, B, GravityVector, <i>ier</i>)	- w m
call cg_gravity_read_f(fn, B, GravityVector, <i>ier</i>)	r - m

Input/Output

fn	CGNS file index number. (<i>Input</i>)
----	--

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B	Base index number, where $1 \leq B \leq \text{nbases}$. (<i>Input</i>)
GravityVector	Description of the convergence information recorded in the data arrays. (<i>Input</i> for cg_gravity_write; <i>output</i> for cg_gravity_read)
ier	Error status. (<i>Output</i>)

10.3 Convergence History

Node: ConvergenceHistory_t

Functions	Modes
<i>ier</i> = cg_convergence_write(int niterations, char *NormDefinitions);	- w m
<i>ier</i> = cg_convergence_read(int *niterations, char **NormDefinitions);	r - m
call cg_convergence_write_f(niterations, NormDefinitions, <i>ier</i>)	- w m
call cg_convergence_read_f(niterations, NormDefinitions, <i>ier</i>)	r - m

Input/ Output

niterations	Number of iterations for which convergence information is recorded. (<i>Input</i> for cg_convergence_write; <i>output</i> for cg_convergence_read)
NormDefinitions	Description of the convergence information recorded in the data arrays. (<i>Input</i> for cg_convergence_write; <i>output</i> for cg_convergence_read)
ier	Error status. (<i>Output</i>)

The function `cg_convergence_write` creates a `ConvergenceHistory_t` node. It must be the first one called when recording convergence history data. The `NormDefinitions` may be left undefined (i.e., a blank string). After creation of this node, the descriptors, data arrays, data class, and dimensional units characterizing the `ConvergenceHistory_t` data structure may be added.

The function `cg_convergence_read` reads a `ConvergenceHistory_t` node. If `NormDefinitions` is not defined in the CGNS database, this function returns a null string. If `NormDefinitions` exists, the library will allocate the space to store the description string, and return the description string to the application. It is the responsibility of the application to free this space when it is no longer needed by a call to `cg_free(NormDefinitions)`, described in [Section 10.6](#).

10.4 Integral Data

Node: IntegralData_t

Functions	Modes
<i>ier</i> = cg_integral_write(char *Name);	- w m
<i>ier</i> = cg_nintegrals(int *nintegrals);	r - m
<i>ier</i> = cg_integral_read(int Index, char *Name);	r - m
call cg_integral_write_f(Name, <i>ier</i>)	- w m
call cg_nintegrals_f(nintegrals, <i>ier</i>)	r - m
call cg_integral_read_f(Index, Name, <i>ier</i>)	r - m

Input/Output

Name	Name of the <code>IntegralData_t</code> data structure. (Input for <code>cg_integral_write</code> ; output for <code>cg_integral_read</code>)
nintegrals	Number of <code>IntegralData_t</code> nodes under current node. (Output)
Index	Integral data index number, where $1 \leq \text{Index} \leq \text{nintegrals}$. (Input)
ier	Error status. (Output)

10.5 User-Defined Data

Node: `UserDefinedData_t`

Functions	Modes
<code>ier = cg_user_data_write(char *Name);</code>	- w m
<code>ier = cg_nuser_data(int *nuserdata);</code>	r - m
<code>ier = cg_user_data_read(int Index, char *Name);</code>	r - m
<code>call cg_user_data_write_f(Name, ier)</code>	- w m
<code>call cg_nuser_data_f(nuserdata, ier)</code>	r - m
<code>call cg_user_data_read_f(Index, Name, ier)</code>	r - m

Input/Output

nuserdata	Number of <code>UserDefinedData_t</code> nodes under current node. (Output)
Name	Name of the <code>UserDefinedData_t</code> node. (Input for <code>cg_user_data_write</code> ; output for <code>cg_user_data_read</code>)
Index	User-defined data index number, where $1 \leq \text{Index} \leq \text{nuserdata}$. (Input)
ier	Error status. (Output)

After accessing a particular `UserDefinedData_t` node using `cg_goto`, the Point Set functions described in [Section 9.2](#) may be used to read or write point set information for the node. The function `cg_gridlocation_write` may also be used to specify the location of the data with respect to the grid (e.g., `Vertex` or `FaceCenter`).

Multiple levels of `UserDefinedData_t` nodes may be written and retrieved by positioning via `cg_goto`. E.g.,

```
ier = cg_goto(fn, B, "Zone_t", Z, "UserDefinedData_t", ud1,
             "UserDefinedData_t", ud2, "UserDefinedData_t", ud3, "end");
```

10.6 Freeing Memory

Functions	Modes
<code>ier = cg_free(char *data);</code>	r w m

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Input/*Output*

<code>data</code>	Character data allocated by the Mid-Level Library. (<i>Input</i>)
<code>ier</code>	Error status. (<i>Output</i>)

This function does not affect the structure of a CGNS file; it is provided as a convenience to free memory allocated by the Mid-Level Library when using C. This isn't necessary in Fortran, and thus an equivalent Fortran function is not provided.

The functions that are used to allocate memory for return values are `cg_descriptor_read`, `cg_convergence_read`, `cg_geo_read`, `cg_link_read`, and `cg_state_read`. Each of these may allocate space to contain the character data returned to the application. It is the responsibility of the application to free this data when it is no longer needed. Calling `cg_free` is identical to calling the standard C function `free`, however it is probably safer in that the memory is freed in the same module in which it is created, particularly when the Mid-Level Library is a shared library or DLL. The routine checks for NULL data and will return `CG_ERROR` in this case, otherwise it returns `CG_OK`.

11 Grid Specification

11.1 Zone Grid Coordinates

Node: GridCoordinates_t

GridCoordinates_t nodes are used to describe grids associated with a particular zone. The original grid must be described by a GridCoordinates_t node named GridCoordinates. Additional GridCoordinates_t nodes may be used, with user-defined names, to store grids at multiple time steps or iterations. In addition to the discussion of the GridCoordinates_t node in the [SIDS](#) and [File Mapping](#) manuals, see the discussion of the ZoneIterativeData_t and ArbitraryGridMotion_t nodes in the SIDS manual.

Functions	Modes
<i>ier</i> = cg_grid_write(int fn, int B, int Z, char *GridCoordName, int *G);	- w m
<i>ier</i> = cg_ngrids(int fn, int B, int Z, int *ngrids);	- w m
<i>ier</i> = cg_grid_read(int fn, int B, int Z, int G, char *GridCoordName);	r - m
call cg_grid_write_f(fn, B, Z, GridCoordName, G, <i>ier</i>)	- w m
call cg_ngrids_f(fn, B, Z, <i>ngrids</i> , <i>ier</i>)	- w m
call cg_grid_read_f(fn, B, Z, G, GridCoordName, <i>ier</i>)	r - m

Input/Output

fn	CGNS file index number. (Input)
B	Base index number, where $1 \leq B \leq \text{nbases}$. (Input)
Z	Zone index number, where $1 \leq Z \leq \text{nzones}$. (Input)
G	Grid index number, where $1 \leq G \leq \text{ngrids}$. (Input for cg_grid_read; output for cg_grid_write)
ngrids	Number of GridCoordinates_t nodes for zone Z. (Output)
GridCoordinateName	Name of the GridCoordinates_t node. Note that the name "GridCoordinates" is reserved for the original grid and must be the first GridCoordinates_t node to be defined. (Input for cg_grid_write; output for cg_grid_read)
ier	Error status. (Output)

The above functions are applicable to any GridCoordinates_t node.

Functions	Modes
<i>ier</i> = cg_coord_write(int fn, int B, int Z, DataType_t datatype, char *coordname, void *coord_array, <i>int *C</i>);	- w m
<i>ier</i> = cg_coord_partial_write(int fn, int B, int Z, DataType_t datatype, char *coordname, int*range_min, int*range_max, void *coord_array, <i>int *C</i>);	- w m
<i>ier</i> = cg_ncoords(int fn, int B, int Z, <i>int *ncoords</i>);	r - m
<i>ier</i> = cg_coord_info(int fn, int B, int Z, int C, <i>DataType_t *datatype</i> , <i>char *coordname</i>);	r - m
<i>ier</i> = cg_coord_read(int fn, int B, int Z, char *coordname, DataType_t datatype, int *range_min, int *range_max, <i>void *coord_array</i>);	r - m
call cg_coord_write_f(fn, B, Z, datatype, coordname, coord_array, <i>C</i> , <i>ier</i>)	- w m
call cg_coord_partial_write_f(fn, B, Z, datatype, coordname, range_min, range_max, coord_array, <i>C</i> , <i>ier</i>)	- w m
call cg_ncoords_f(fn, B, Z, <i>ncoords</i> , <i>ier</i>)	r - m
call cg_coord_info_f(fn, B, Z, C, <i>datatype</i> , <i>coordname</i> , <i>ier</i>)	r - m
call cg_coord_read_f(fn, B, Z, coordname, datatype, range_min, range_max, <i>coord_array</i> , <i>ier</i>)	r - m

Input/Output

fn	CGNS file index number. (Input)
B	Base index number, where $1 \leq B \leq \text{nbases}$. (Input)
Z	Zone index number, where $1 \leq Z \leq \text{nzones}$. (Input)
C	Coordinate array index number, where $1 \leq C \leq \text{ncoords}$. (Input for cg_coord_info; <i>output</i> for cg_coord_write)
ncoords	Number of coordinate arrays for zone Z. (<i>Output</i>)
datatype	Data type in which the coordinate array is written. Admissible data types for a coordinate array are RealSingle and RealDouble. (Input for cg_coord_write, cg_coord_partial_write, cg_coord_read; <i>output</i> for cg_coord_info)
coordname	Name of the coordinate array. It is strongly advised to use the SIDS nomenclature conventions when naming the coordinate arrays to insure file compatibility. (Input for cg_coord_write, cg_coord_partial_write, cg_coord_read; <i>output</i> for cg_coord_info)
range_min	Lower range index (eg., imin, jmin, kmin). (Input)
range_max	Upper range index (eg., imax, jmax, kmax). (Input)
coord_array	Array of coordinate values for the range prescribed. (Input for cg_coord_write; cg_coord_partial_write, <i>output</i> for cg_coord_read)

`ier` Error status. (*Output*)

The above functions are applicable *only* to the `GridCoordinates_t` node named `GridCoordinates`, used for the original grid in a zone. Coordinates for additional `GridCoordinates_t` nodes in a zone must be read and written using the `cg_array_xxx` functions described in [Section 8.1](#).

When writing, the function `cg_coord_write` will automatically write the full range of coordinates (i.e., the entire `coord_array`). The function `cg_coord_partial_write` may be used to write only a subset of `coord_array`.

If the file was opened in “write mode”, using `cg_coord_partial_write` will overwrite existing coordinates only for the specified range. In “modify mode”, the existing coordinates will first be deleted, then replaced by the new coordinates.

The function `cg_coord_read` returns the coordinate array `coord_array`, for the range prescribed by `range_min` and `range_max`. The array is returned to the application in the data type requested in `datatype`. This data type does not need to be the same as the one in which the coordinates are stored in the file. A coordinate array stored as double precision in the CGNS file can be returned to the application as single precision, or vice versa.

In Fortran, when using `cg_coord_read_f` to read 2D or 3D coordinates, the extent of each dimension of `coord_array` must be consistent with the requested range. When reading a 1D solution, the declared size can be larger than the requested range. For example, for a 2D zone with 100×50 vertices, if `range_min` and `range_max` are set to (11,11) and (20,20) to read a subset of the coordinates, then `coord_array` must be dimensioned (10,10). If `coord_array` is declared larger (e.g., (100,50)) the indices for the returned coordinates will be wrong.

11.2 Element Connectivity

Node: Elements_t

Functions	Modes
<i>ier</i> = cg_section_write(int fn, int B, int Z, char *ElementSectionName, ElementType_t type, int start, int end, int nbndry, int *Elements, int *S);	- w m
<i>ier</i> = cg_section_partial_write(int fn, int B, int Z, char *ElementSectionName, ElementType_t type, int rmin_elems, int rmax_elems, int nbndry, int *Elements, int *S);	- w m
<i>ier</i> = cg_parent_data_write(int fn, int B, int Z, int S, int *ParentData);	- w m
<i>ier</i> = cg_parent_data_partial_write(int fn, int B, int Z, int S, int rmin_parent, int rmax_parent, int *ParentData);	- w m
<i>ier</i> = cg_nsections(int fn, int B, int Z, int *nsections);	r - m
<i>ier</i> = cg_section_read(int fn, int B, int Z, int S, char *ElementSectionName, ElementType_t *type, int *rmin_elems, int *rmax_elems, int *nbndry, int *parent_flag);	r - m
<i>ier</i> = cg_section_read_ext(int fn, int B, int Z, int S, char *ElementSectionName, ElementType_t *type, int *rmin_elems, int *rmax_elems, int *nbndry, int *parent_flag, int *rmin_parent, int *rmax_parent);	r - m
<i>ier</i> = cg_ElementDataSize(int fn, int B, int Z, int S, int *ElementDataSize);	r - m
<i>ier</i> = cg_elements_read(int fn, int B, int Z, int S, int *Elements, int *ParentData);	r - m
<i>ier</i> = cg_elements_read_ext(int fn, int B, int Z, int S, int *Elements, int *rmin_elems, int *rmax_elems, int *ParentData, int *rmin_parent, int *rmax_parent);	r - m
<i>ier</i> = cg_npe(ElementType_t type, int *npe);	r w m

Functions	Modes
call cg_section_write_f(fn, B, Z, ElementSectionName, type, start, end, nbndry, Elements, S, ier)	- w m
call cg_section_write_partial_f(fn, B, Z, ElementSectionName, type, rmin_elems, rmax_elems, nbndry, Elements, S, ier)	- w m
call cg_parent_data_write_f(fn, B, Z, S, ParentData, ier)	- w m
call cg_parent_data_partial_write_f(fn, B, Z, S, rmin_parent, rmax_parent, ParentData, ier)	- w m
call cg_nsections_f(fn, B, Z, nsections, ier)	r - m
call cg_section_read_f(fn, B, Z, S, ElementSectionName, type, rmin_elems, rmax_elems, nbndry, parent_flag, ier)	r - m
call cg_section_read_ext_f(fn, B, Z, S, ElementSectionName, type, rmin_elems, rmax_elems, nbndry, parent_flag, rmin_parent, rmax_parent, ier)	r - m
call cg_ElementDataSize_f(fn, B, Z, S, ElementDataSize, ier)	r - m
call cg_elements_read_f(fn, B, Z, S, Elements, ParentData, ier)	r - m
call cg_elements_read_ext_f(fn, B, Z, S, Elements, rmin_elems, rmax_elems, ParentData, rmin_parent, rmax_parent, ier)	r - m
call cg_npe_f(type, npe, ier)	r w m

Input/Output

fn	CGNS file index number. (Input)
B	Base index number, where $1 \leq B \leq \text{nbases}$. (Input)
Z	Zone index number, where $1 \leq Z \leq \text{nzones}$. (Input)
ElementSectionName	Name of the Elements_t node. (Input for cg_section_write; output for cg_section_read)
type	Type of element. See the eligible types for ElementType_t in Section 2.4. (Input for cg_section_write, cg_npe; output for cg_section_read)
start	Index of first element in the section. (Input for cg_section_write; output for cg_section_read, cg_section_read_ext)
end	Index of last element in the section. (Input for cg_section_write; output for cg_section_read, cg_section_read_ext)
rmin_elems	Lower element index. (Input)
rmax_elems	Upper element index. (Input)
rmin_parent	Lower element index for parent data. (Input for cg_parent_data_partial_write, cg_elements_read_ext; output for cg_section_read_ext)
rmax_parent	Upper element index for parent data. (Input for cg_parent_data_partial_write, cg_elements_read_ext; output for cg_section_read_ext)

<code>nbndry</code>	Index of last boundary element in the section. Set to zero if the elements are unsorted. (Input for <code>cg_section_write</code> ; <i>output</i> for <code>cg_section_read</code>)
<code>nsections</code>	Lower range index (eg., <code>imin</code> , <code>jmin</code> , <code>kmin</code>). (<i>Output</i>)
<code>S</code>	Element section index, where $1 \leq S \leq nsections$. (Input for <code>cg_parent_data_write</code> , <code>cg_section_read</code> , <code>cg_ElementDataSize</code> , <code>cg_elements_read</code> ; <i>output</i> for <code>cg_section_write</code>)
<code>parent_flag</code>	Flag indicating if the parent data are defined. If the parent data exist, <code>parent_flag</code> is set to 1; otherwise it is set to 0. (<i>Output</i>)
<code>ElementDataSize</code>	Number of element connectivity data values. (<i>Output</i>)
<code>Elements</code>	Element connectivity data. (Input for <code>cg_section_write</code> ; <i>output</i> for <code>cg_elements_read</code>)
<code>ParentData</code>	For boundary or interface elements, this array contains information on the cell(s) and cell face(s) sharing the element. (<i>Output</i>)
<code>npe</code>	Number of nodes for an element of type <code>type</code> . (<i>Output</i>)
<code>ier</code>	Error status. (<i>Output</i>)

If the specified `Elements_t` node doesn't yet exist, it may be created using either `cg_section_write` or `cg_section_partial_write`. If the `Elements_t` node does exist (created by using either `cg_section_write` or `cg_section_partial_write`), calls to `cg_section_partial_write` will replace the existing connectivity data with the union of the existing and new data, with the new data overwriting the old data for common indices. The resulting index range for the new data must be continuous.

The function `cg_parent_data_write` will automatically write the full range of parent data (i.e., the entire `ParentData` array). If parent data does not exist for the specified `Elements_t` node, the first use of `cg_parent_data_partial_write` will add it. If parent data does exist (created by using either `cg_parent_data_write` or `cg_parent_data_partial_write`), calls to `cg_parent_data_partial_write` will replace the existing parent data with the union of the existing and new data, with the new data overwriting the old data for common indices. The resulting index range for the new data must be continuous.

The “partial write” capability described above requires that the file be opened in “write mode”. For both `cg_section_partial_write` and `cg_parent_data_partial_write`, if the file was opened in “modify mode”, the existing connectivity or parent data will first be deleted, then replaced by the new data.

The function `cg_section_read_ext` returns the same information as `cg_section_read`, plus the index range for the parent data.

The function `cg_elements_read` returns all of the element connectivity and parent data. Specified subsets of the element connectivity and parent data may be read using `cg_elements_read_ext`.

11.3 Axisymmetry

Node: `Axisymmetry_t`

Functions	Modes
<i>ier</i> = cg_axisym_write(int fn, int B, float *ReferencePoint, float *AxisVector);	- w m
<i>ier</i> = cg_axisym_read(int fn, int B, float *ReferencePoint, float *AxisVector);	r - m
call cg_axisym_write_f(fn, B, ReferencePoint, AxisVector, <i>ier</i>)	- w m
call cg_axisym_read_f(fn, B, ReferencePoint, AxisVector, <i>ier</i>)	r - m

Input/Output

fn	CGNS file index number. (<i>Input</i>)
B	Base index number, where $1 \leq B \leq \text{nbases}$. (<i>Input</i>)
ReferencePoint	Origin used for defining the axis of rotation. (<i>Input</i> for cg_axisym_write; <i>output</i> for cg_axisym_read)
AxisVector	Direction cosines of the axis of rotation, through the reference point. (<i>Input</i> for cg_axisym_write; <i>output</i> for cg_axisym_read)
ier	Error status. (<i>Output</i>)

This node can only be used for a bi-dimensional model, i.e., PhysicalDimension must equal two.

11.4 Rotating Coordinates

Node: RotatingCoordinates_t

Functions	Modes
<i>ier</i> = cg_rotating_write(float *RotationRateVector, float *RotationCenter);	- w m
<i>ier</i> = cg_rotating_read(float *RotationRateVector, float *RotationCenter);	r - m
call cg_rotating_write_f(RotationRateVector, RotationCenter, <i>ier</i>)	- w m
call cg_rotating_read_f(RotationRateVector, RotationCenter, <i>ier</i>)	r - m

Input/Output

RotationRateVector	Components of the angular velocity of the grid about the center of rotation. (<i>Input</i> for cg_rotating_write; <i>output</i> for cg_rotating_read)
RotationCenter	Coordinates of the center of rotation. (<i>Input</i> for cg_rotating_write; <i>output</i> for cg_rotating_read)
ier	Error status. (<i>Output</i>)

12 Solution Data

12.1 Flow Solution

Node: FlowSolution_t

Functions	Modes
<i>ier</i> = cg_sol_write(int fn, int B, int Z, char *solname, GridLocation_t location, int *S);	- w m
<i>ier</i> = cg_nsols(int fn, int B, int Z, int *nsols);	r - m
<i>ier</i> = cg_sol_info(int fn, int B, int Z, int S, char *solname, GridLocation_t *location);	r - m
call cg_sol_write_f(fn, B, Z, solname, location, S, ier)	- w m
call cg_nsols_f(fn, B, Z, nsols, ier)	r - m
call cg_sol_info_f(fn, B, Z, S, solname, location, ier)	r - m

Input/Output

fn	CGNS file index number. (Input)
B	Base index number, where $1 \leq B \leq \text{nbases}$. (Input)
Z	Zone index number, where $1 \leq Z \leq \text{nzones}$. (Input)
S	Flow solution index number, where $1 \leq S \leq \text{nsols}$. (Input for cg_sol_info; <i>output</i> for cg_sol_write)
nsols	Number of flow solutions for zone Z. (<i>Output</i>)
solname	Name of the flow solution. (Input for cg_sol_write; <i>output</i> for cg_sol_info)
location	Grid location where the solution is recorded. The current admissible locations are Vertex, CellCenter, IFaceCenter, JFaceCenter, and KFaceCenter. (Input for cg_sol_write; <i>output</i> for cg_sol_info)
ier	Error status. (<i>Output</i>)

The above functions are used to create, and get information about, FlowSolution_t nodes.

Functions	Modes
<i>ier</i> = cg_field_write(int fn, int B, int Z, int S, DataType_t datatype, char *fieldname, void *solution_array, <i>int *F</i>);	- w m
<i>ier</i> = cg_field_partial_write(int fn, int B, int Z, int S, DataType_t datatype, char *fieldname, int *range_min, int *range_max, void *solution_array, <i>int *F</i>);	- w m
<i>ier</i> = cg_nfields(int fn, int B, int Z, int S, <i>int *nfields</i>);	r - m
<i>ier</i> = cg_field_info(int fn, int B, int Z, int S, int F, DataType_t *datatype, char *fieldname);	r - m
<i>ier</i> = cg_field_read(int fn, int B, int Z, int S, char *fieldname, DataType_t datatype, int *range_min, int *range_max, void *solution_array);	r - m
call cg_field_write_f(fn, B, Z, S, datatype, fieldname, solution_array, <i>F, ier</i>)	- w m
call cg_field_partial_write_f(fn, B, Z, S, datatype, fieldname, range_min, range_max, solution_array, <i>F, ier</i>)	- w m
call cg_nfields_f(fn, B, Z, S, <i>nfields, ier</i>)	r - m
call cg_field_info_f(fn, B, Z, S, F, <i>datatype, fieldname, ier</i>)	r - m
call cg_field_read_f(fn, B, Z, S, fieldname, datatype, range_min, range_max, <i>solution_array, ier</i>)	r - m

Input/Output

fn	CGNS file index number. (<i>Input</i>)
B	Base index number, where $1 \leq B \leq \text{nbases}$. (<i>Input</i>)
Z	Zone index number, where $1 \leq Z \leq \text{nzones}$. (<i>Input</i>)
S	Flow solution index number, where $1 \leq S \leq \text{nsols}$. (<i>Input</i>)
F	Solution array index number, where $1 \leq F \leq \text{nfields}$. (<i>Input</i> for cg_field_info; <i>output</i> for cg_field_write)
nfields	Number of data arrays in flow solution S. (<i>Output</i>)
datatype	Data type in which the solution array is written. Admissible data types for a solution array are Integer, RealSingle, and RealDouble. (<i>Input</i> for cg_field_write, cg_field_read; <i>output</i> for cg_field_info)
fieldname	Name of the solution array. It is strongly advised to use the SIDS nomenclature conventions when naming the solution arrays to insure file compatibility. (<i>Input</i> for cg_field_write, cg_field_read; <i>output</i> for cg_field_info)
range_min	Lower range index (eg., imin, jmin, kmin). (<i>Input</i>)
range_max	Upper range index (eg., imax, jmax, kmax). (<i>Input</i>)
solution_array	Array of solution values for the range prescribed. (<i>Input</i> for cg_field_write; <i>output</i> for cg_field_read)

ier Error status. (*Output*)

The above functions are used to read and write solution arrays stored below a `FlowSolution_t` node.

When writing, the function `cg_field_write` will automatically write the full range of the solution (i.e., the entire `solution_array`). The function `cg_field_partial_write` may be used to write only a subset of `solution_array`.

If the file was opened in “write mode”, using `cg_field_partial_write` will overwrite the existing solution only for the specified range. In “modify mode”, the existing solution will first be deleted, then replaced by the new solution.

The function `cg_field_read` returns the solution array `fieldname`, for the range prescribed by `range_min` and `range_max`. The array is returned to the application in the data type requested in `datatype`. This data type does not need to be the same as the one in which the data is stored in the file. A solution array stored as double precision in the CGNS file can be returned to the application as single precision, or vice versa.

In Fortran, when using `cg_field_read_f` to read a 2D or 3D solution, the extent of each dimension of `solution_array` must be consistent with the requested range. When reading a 1D solution, the declared size can be larger than the requested range. For example, for a 2D zone with 100×50 vertices, if `range_min` and `range_max` are set to (11,11) and (20,20) to read a subset of the solution, then `solution_array` must be dimensioned (10,10). If `solution_array` is declared larger (e.g., (100,50)) the indices for the returned array values will be wrong.

12.2 Discrete Data

Node: `DiscreteData_t`

Functions	Modes
<code>ier = cg_discrete_write(int fn, int B, int Z, char *DiscreteName, int *D);</code>	- w m
<code>ier = cg_ndiscrete(int fn, int B, int Z, int *ndiscrete);</code>	r - m
<code>ier = cg_discrete_read(int fn, int B, int Z, int D, char *DiscreteName);</code>	r - m
<code>call cg_discrete_write_f(fn, B, Z, DiscreteName, D, ier)</code>	- w m
<code>call cg_ndiscrete_f(fn, B, Z, ndiscrete, ier)</code>	r - m
<code>call cg_discrete_read_f(fn, B, Z, D, DiscreteName, ier)</code>	r - m

Input/Output

fn CGNS file index number. (*Input*)

B Base index number, where $1 \leq B \leq \text{nbases}$. (*Input*)

Z Zone index number, where $1 \leq Z \leq \text{nzones}$. (*Input*)

D Discrete data index number, where $1 \leq D \leq \text{ndiscrete}$. (*Input* for `cg_discrete_read`; *output* for `cg_discrete_write`)

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<code>ndiscrete</code>	Number of <code>DiscreteData_t</code> data structures under zone Z. (<i>Output</i>)
<code>DiscreteName</code>	Name of <code>DiscreteData_t</code> data structure. (<i>Input</i> for <code>cg_discrete_write</code> ; <i>output</i> for <code>cg_discrete_read</code>)
<code>ier</code>	Error status. (<i>Output</i>)

`DiscreteData_t` nodes are intended for the storage of fields of data not usually identified as part of the flow solution, such as fluxes or equation residuals.

13 Grid Connectivity

13.1 One-to-One Connectivity

Node: GridConnectivity1to1_t

Functions	Modes
<i>ier</i> = cg_n1to1_global(int <i>fn</i> , int <i>B</i> , int * <i>n1to1_global</i>);	r - m
<i>ier</i> = cg_1to1_read_global(int <i>fn</i> , int <i>B</i> , char ** <i>connectname</i> , char ** <i>zonename</i> , char ** <i>donorname</i> , int ** <i>range</i> , int ** <i>donor_range</i> , int ** <i>transform</i>);	r - m
call cg_n1to1_global_f(<i>fn</i> , <i>B</i> , <i>n1to1_global</i> , <i>ier</i>)	r - m
call cg_1to1_read_global_f(<i>fn</i> , <i>B</i> , <i>connectname</i> , <i>zonename</i> , <i>donorname</i> , <i>range</i> , <i>donor_range</i> , <i>transform</i> , <i>ier</i>)	r - m

Input/Output

<i>fn</i>	CGNS file index number. (Input)
<i>B</i>	Base index number, where $1 \leq B \leq \text{nbases}$. (Input)
<i>n1to1_global</i>	Total number of one-to-one interfaces in base <i>B</i> , stored under GridConnectivity1to1_t nodes. (I.e., this does not include one-to-one interfaces that may be stored under GridConnectivity_t nodes, used for generalized zone interfaces.) Note that the function cg_n1to1 (described below) may be used to get the number of one-to-one interfaces in a specific zone. (Output)
<i>connectname</i>	Name of the interface. (Output)
<i>zonename</i>	Name of the first zone, for all one-to-one interfaces in base <i>B</i> . (Output)
<i>donorname</i>	Name of the second zone, for all one-to-one interfaces in base <i>B</i> . (Output)
<i>range</i>	Range of points for the first zone, for all one-to-one interfaces in base <i>B</i> . (Output)
<i>donor_range</i>	Range of points for the current zone, for all one-to-one interfaces in base <i>B</i> . (Output)
<i>transform</i>	Short hand notation for the transformation matrix defining the relative orientation of the two zones. This transformation is given for all one-to-one interfaces in base <i>B</i> . See the description of GridConnectivity1to1_t in the SIDS manual for details. (Output)
<i>ier</i>	Error status. (Output)

The above functions may be used to get information about all the one-to-one zone interfaces in a CGNS database.

Functions	Modes
<i>ier</i> = cg_1to1_write(int fn, int B, int Z, char *connectname, char *donorname, int *range, int *donor_range, int *transform, int *I);	- w m
<i>ier</i> = cg_n1to1(int fn, int B, int Z, int *n1to1);	r - m
<i>ier</i> = cg_1to1_read(int fn, int B, int Z, int I, char *connectname, char *donorname, int *range, int *donor_range, int *transform);	r - m
call cg_1to1_write_f(fn, B, Z, connectname, donorname, range, donor_range, transform, I, <i>ier</i>)	- w m
call cg_n1to1_f(fn, B, Z, n1to1, <i>ier</i>)	r - m
call cg_1to1_read_f(fn, B, Z, I, connectname, donorname, range, donor_range, transform, <i>ier</i>)	r - m

Input/Output

fn	CGNS file index number. (Input)
B	Base index number, where $1 \leq B \leq \text{nbases}$. (Input)
Z	Zone index number, where $1 \leq Z \leq \text{nzones}$. (Input)
I	Interface index number, where $1 \leq I \leq \text{n1to1}$. (Input for cg_1to1_read; output for cg_1to1_write)
n1to1	Number of one-to-one interfaces in zone Z, stored under GridConnectivity1to1_t nodes. (I.e., this does not include one-to-one interfaces that may be stored under GridConnectivity_t nodes, used for generalized zone interfaces.) (Output)
connectname	Name of the interface. (Input for cg_1to1_write; output for cg_1to1_read)
donorname	Name of the zone interfacing with the current zone. (Input for cg_1to1_write; output for cg_1to1_read)
range	Range of points for the current zone. (Input for cg_1to1_write; output for cg_1to1_read)
donor_range	Range of points for the donor zone. (Input for cg_1to1_write; output for cg_1to1_read)
transform	Short hand notation for the transformation matrix defining the relative orientation of the two zones. See the description of GridConnectivity1to1_t in the SIDS manual for details. (Input for cg_1to1_write; output for cg_1to1_read)
ier	Error status. (Output)

The above functions are used to read and write one-to-one connectivity data for a specific zone.

13.2 Generalized Connectivity

Node: GridConnectivity_t

Functions	Modes
<pre>ier = cg_conn_write(int fn, int B, int Z, char *connectname, GridLocation_t location, GridConnectivityType_t connect_type, PointSetType_t ptset_type, int npnts, int *pnts, char *donorname, ZoneType_t donor_zonetype, PointSetType_t donor_ptset_type, DataType_t donor_datatype, int ndata_donor, void *donor_data, int *I);</pre>	- w m
<pre>ier = cg_conn_write_short(int fn, int B, int Z, char *connectname, GridLocation_t location, GridConnectivityType_t connect_type, PointSetType_t ptset_type, int npnts, int *pnts, char *donorname, int *I);</pre>	- w m
<pre>ier = cg_nconns(int fn, int B, int Z, int *nconns);</pre>	r - m
<pre>ier = cg_conn_info(int fn, int B, int Z, int I, char *connectname, GridLocation_t *location, GridConnectivityType_t *connect_type, PointSetType_t *ptset_type, int *npnts, char *donorname, ZoneType_t *donor_zonetype, PointSetType_t *donor_ptset_type, DataType_t *donor_datatype, int *ndata_donor);</pre>	r - m
<pre>ier = cg_conn_read(int fn, int B, int Z, int I, int *pnts, DataType_t donor_datatype, void *donor_data);</pre>	r - m
<pre>call cg_conn_write_f(fn, B, Z, connectname, location, connect_type, ptset_type, npnts, pnts, donorname, donor_zonetype, donor_ptset_type, donor_datatype, ndata_donor, donor_data, I, ier)</pre>	- w m
<pre>call cg_conn_write_short_f(fn, B, Z, connectname, location, connect_type, ptset_type, npnts, pnts, donorname, I, ier)</pre>	- w m
<pre>call cg_nconns_f(fn, B, Z, nconns, ier)</pre>	r - m
<pre>call cg_conn_info_f(fn, B, Z, I, connectname, location, connect_type, ptset_type, npnts, donorname, donor_zonetype, donor_ptset_type, donor_datatype, ndata_donor, ier)</pre>	r - m
<pre>call cg_conn_read_f(fn, B, Z, I, pnts, donor_datatype, donor_data, ier)</pre>	r - m

Input/Output

fn	CGNS file index number. (Input)
B	Base index number, where $1 \leq B \leq \text{nbases}$. (Input)
Z	Zone index number, where $1 \leq Z \leq \text{nzones}$. (Input)
I	Discrete data index number, where $1 \leq I \leq \text{nconns}$. (Input for <code>cg_conn_info</code> , <code>cg_conn_read</code> ; <i>output</i> for <code>cg_conn_write</code> , <code>cg_conn_write_short</code>)

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nconns	Number of interfaces for zone Z. (<i>Output</i>)
connectname	Name of the interface. (<i>Input</i> for <code>cg_conn_write</code> , <code>cg_conn_write_short</code> ; <i>output</i> for <code>cg_conn_info</code>)
location	Grid location used in the definition of the point set. The currently admissible locations are <code>Vertex</code> and <code>CellCenter</code> . (<i>Input</i> for <code>cg_conn_write</code> , <code>cg_conn_write_short</code> ; <i>output</i> for <code>cg_conn_info</code>)
connect_type	Type of interface being defined. The admissible types are <code>Overset</code> , <code>Abutting</code> , and <code>Abutting1to1</code> . (<i>Input</i> for <code>cg_conn_write</code> , <code>cg_conn_write_short</code> ; <i>output</i> for <code>cg_conn_info</code>)
ptset_type	Type of point set defining the interface in the current zone; either <code>PointRange</code> or <code>PointList</code> . (<i>Input</i> for <code>cg_conn_write</code> , <code>cg_conn_write_short</code> ; <i>output</i> for <code>cg_conn_info</code>)
donor_ptset_type	Type of point set defining the interface in the donor zone; either <code>PointListDonor</code> or <code>CellListDonor</code> . (<i>Input</i> for <code>cg_conn_write</code> ; <i>output</i> for <code>cg_conn_info</code>)
npnts	Number of points defining the interface in the current zone. For a <code>ptset_type</code> of <code>PointRange</code> , <code>npnts</code> is always two. For a <code>ptset_type</code> of <code>PointList</code> , <code>npnts</code> is the number of points in the <code>PointList</code> . (<i>Input</i> for <code>cg_conn_write</code> , <code>cg_conn_write_short</code> ; <i>output</i> for <code>cg_conn_info</code>)
ndata_donor	Number of points or cells in the current zone. These are paired with points, cells, or fractions thereof in the donor zone. (<i>Input</i> for <code>cg_conn_write</code> ; <i>output</i> for <code>cg_conn_info</code>)
donorname	Name of the zone interfacing with the current zone. (<i>Input</i> for <code>cg_conn_write</code> ; <i>output</i> for <code>cg_conn_info</code>)
donor_datatype	Data type in which the donor points are stored in the file. The only admissible type, as of version 2.0 of the Mid-Level Library, is <code>Integer</code> . The <code>donor_datatype</code> argument was left in these functions only for backward compatibility. (<i>Input</i> for <code>cg_conn_write</code> , <code>cg_conn_read</code> ; <i>output</i> for <code>cg_conn_info</code>)
pnts	Array of points defining the interface in the current zone. (<i>Input</i> for <code>cg_conn_write</code> , <code>cg_conn_write_short</code> ; <i>output</i> for <code>cg_conn_read</code>)
donor_data	Array of donor points or cells corresponding to <code>ndata_donor</code> . Note that it is possible that the same donor point or cell may be used multiple times. (<i>Input</i> for <code>cg_conn_write</code> ; <i>output</i> for <code>cg_conn_read</code>)
donor_zonetype	Type of the donor zone. The admissible types are <code>Structured</code> and <code>Unstructured</code> . (<i>Input</i> for <code>cg_conn_write</code> ; <i>output</i> for <code>cg_conn_info</code>)
ier	Error status. (<i>Output</i>)

Note that the interpolation factors stored in the `InterpolantsDonor` data array are accessed using the `cg_goto` and `cg_array_xxx` functions, described in [Section 4](#) and [Section 8.1](#), respectively.

13.3 Special Grid Connectivity Properties

Node: GridConnectivityProperty_t

Functions	Modes
<i>ier</i> = cg_conn_periodic_write(int fn, int B, int Z, int I, float *RotationCenter, float *RotationAngle, float *Translation);	- w m
<i>ier</i> = cg_conn_average_write(int fn, int B, int Z, int I, AverageInterfaceType_t AverageInterfaceType);	- w m
<i>ier</i> = cg_1to1_periodic_write(int fn, int B, int Z, int I, float *RotationCenter, float *RotationAngle, float *Translation);	- w m
<i>ier</i> = cg_1to1_average_write(int fn, int B, int Z, int I, AverageInterfaceType_t AverageInterfaceType);	- w m
<i>ier</i> = cg_conn_periodic_read(int fn, int B, int Z, int I, float *RotationCenter, float *RotationAngle, float *Translation);	r - m
<i>ier</i> = cg_conn_average_read(int fn, int B, int Z, int I, AverageInterfaceType_t *AverageInterfaceType);	r - m
<i>ier</i> = cg_1to1_periodic_read(int fn, int B, int Z, int I, float *RotationCenter, float *RotationAngle, float *Translation);	r - m
<i>ier</i> = cg_1to1_average_read(int fn, int B, int Z, int I, AverageInterfaceType_t *AverageInterfaceType);	r - m
call cg_conn_periodic_write_f(fn, B, Z, I, RotationCenter, RotationAngle, Translation, <i>ier</i>)	- w m
call cg_conn_average_write_f(fn, B, Z, I, AverageInterfaceType, <i>ier</i>)	- w m
call cg_1to1_periodic_write_f(fn, B, Z, I, RotationCenter, RotationAngle, Translation, <i>ier</i>)	- w m
call cg_1to1_average_write_f(fn, B, Z, I, AverageInterfaceType, <i>ier</i>)	- w m
call cg_conn_periodic_read_f(fn, B, Z, I, RotationCenter, RotationAngle, Translation, <i>ier</i>)	r - m
call cg_conn_average_read_f(fn, B, Z, I, AverageInterfaceType, <i>ier</i>)	r - m
call cg_1to1_periodic_read_f(fn, B, Z, I, RotationCenter, RotationAngle, Translation, <i>ier</i>)	r - m
call cg_1to1_average_read_f(fn, B, Z, I, AverageInterfaceType, <i>ier</i>)	r - m

Input/Output

fn	CGNS file index number. (Input)
B	Base index number, where $1 \leq B \leq \text{nbases}$. (Input)
Z	Zone index number, where $1 \leq Z \leq \text{nzones}$. (Input)
I	Grid connectivity index number, where $1 \leq I \leq \text{nconns}$ for the “cg_conn” functions, and $1 \leq I \leq \text{n1to1}$ for the “cg_1to1” functions. (Input)

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RotationCenter	An array of size <code>phys_dim</code> defining the coordinates of the origin for defining the rotation angle between the periodic interfaces. (<code>phys_dim</code> is the number of coordinates required to define a vector in the field.) (Input for <code>cg_conn_periodic_write</code> , <code>cg_1to1_periodic_write</code> ; output for <code>cg_conn_periodic_read</code> , <code>cg_1to1_periodic_read</code>)
RotationAngle	An array of size <code>phys_dim</code> defining the rotation angle from the current interface to the connecting interface. (Input for <code>cg_conn_periodic_write</code> , <code>cg_1to1_periodic_write</code> ; output for <code>cg_conn_periodic_read</code> , <code>cg_1to1_periodic_read</code>)
Translation	An array of size <code>phys_dim</code> defining the translation from the current interface to the connecting interface. (Input for <code>cg_conn_periodic_write</code> , <code>cg_1to1_periodic_write</code> ; output for <code>cg_conn_periodic_read</code> , <code>cg_1to1_periodic_read</code>)
AverageInterfaceType	The type of averaging to be done. Valid types are Null, UserDefined, AverageAll, AverageCircumferential, AverageRadial, AverageI, AverageJ, and AverageK. (Input for <code>cg_conn_average_write</code> , <code>cg_1to1_average_write</code> ; output for <code>cg_conn_average_read</code> , <code>cg_1to1_average_read</code>)
ier	Error status. (Output)

These functions may be used to store special grid connectivity properties. The “`cg_conn`” functions apply to generalized grid connectivity nodes (i.e., `GridConnectivity_t`), and the “`cg_1to1`” functions apply to 1-to-1 grid connectivity nodes (i.e., `GridConnectivity1to1_t`).

The “write” functions will create the `GridConnectivityProperty_t` node if it doesn’t already exist, then add the appropriate connectivity property. Multiple connectivity properties may be recorded under the same `GridConnectivityProperty_t` node.

The “read” functions will return with `ier = 2 = CG_NODE_NOT_FOUND` if the requested connectivity property, or the `GridConnectivityProperty_t` node itself, doesn’t exist.

13.4 Overset Holes

Node: OversetHoles_t

Functions	Modes
<i>ier</i> = cg_hole_write(int <i>fn</i> , int <i>B</i> , int <i>Z</i> , char * <i>holename</i> , GridLocation_t <i>location</i> , PointSetType_t <i>ptset_type</i> , int <i>nptsets</i> , int <i>npnts</i> , int * <i>pnts</i> , int * <i>I</i>);	- w m
<i>ier</i> = cg_nholes(int <i>fn</i> , int <i>B</i> , int <i>Z</i> , int * <i>nholes</i>);	r - m
<i>ier</i> = cg_hole_info(int <i>fn</i> , int <i>B</i> , int <i>Z</i> , int <i>I</i> , char * <i>holename</i> , GridLocation_t * <i>location</i> , PointSetType_t * <i>ptset_type</i> , int * <i>nptsets</i> , int * <i>npnts</i>);	r - m
<i>ier</i> = cg_hole_read(int <i>fn</i> , int <i>B</i> , int <i>Z</i> , int <i>I</i> , int * <i>pnts</i>);	r - m
call cg_hole_write_f(<i>fn</i> , <i>B</i> , <i>Z</i> , <i>holename</i> , <i>location</i> , <i>ptset_type</i> , <i>nptsets</i> , <i>npnts</i> , <i>pnts</i> , <i>I</i> , <i>ier</i>)	- w m
call cg_nholes_f(<i>fn</i> , <i>B</i> , <i>Z</i> , <i>nholes</i> , <i>ier</i>)	r - m
call cg_hole_info_f(<i>fn</i> , <i>B</i> , <i>Z</i> , <i>I</i> , <i>holename</i> , <i>location</i> , <i>ptset_type</i> , <i>nptsets</i> , <i>npnts</i> , <i>ier</i>)	r - m
call cg_hole_read_f(<i>fn</i> , <i>B</i> , <i>Z</i> , <i>I</i> , <i>pnts</i> , <i>ier</i>)	r - m

Input/Output

<i>fn</i>	CGNS file index number. (Input)
<i>B</i>	Base index number, where $1 \leq B \leq \text{nbases}$. (Input)
<i>Z</i>	Zone index number, where $1 \leq Z \leq \text{nzones}$. (Input)
<i>I</i>	Overset hole index number, where $1 \leq I \leq \text{nholes}$. (Input for cg_hole_info, cg_hole_read; output for cg_hole_write)
<i>nholes</i>	Number of overset holes in zone <i>Z</i> . (Output)
<i>holename</i>	Name of the overset hole. (Input for cg_hole_write; output for cg_hole_info)
<i>location</i>	Grid location used in the definition of the point set. The currently admissible locations are Vertex and CellCenter. (Input for cg_hole_write; output for cg_hole_info)
<i>ptset_type</i>	The extent of the overset hole may be defined using a range of points or cells, or using a discrete list of all points or cells in the overset hole. If a range of points or cells is used, <i>ptset_type</i> is set to PointRange. When a discrete list of points or cells is used, <i>ptset_type</i> equals PointList. (Input for cg_hole_write; output for cg_hole_info)
<i>nptsets</i>	Number of point sets used to define the hole. If <i>ptset_type</i> is PointRange, several point sets may be used. If <i>ptset_type</i> is PointList, only one point set is allowed. (Input for cg_hole_write; output for cg_hole_info)

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<code>npnts</code>	Number of points (or cells) in the point set. For a <code>ptset_type</code> of <code>PointRange</code> , <code>npnts</code> is always two. For a <code>ptset_type</code> of <code>PointList</code> , <code>npnts</code> is the number of points or cells in the <code>PointList</code> . (<i>Input</i> for <code>cg_hole_write</code> ; <i>output</i> for <code>cg_hole_info</code>)
<code>pnts</code>	Array of points or cells in the point set. (<i>Input</i> for <code>cg_hole_write</code> ; <i>output</i> for <code>cg_hole_read</code>)
<code>ier</code>	Error status. (<i>Output</i>)

14 Boundary Conditions

14.1 Boundary Condition Type and Location

Node: BC_t

Functions	Modes
<i>ier</i> = cg_boco_write(int fn, int B, int Z, char *boconame, BCTYPE_t bocotype, PointSetType_t ptset_type, int npnts, int *pnts, int *BC);	- w m
<i>ier</i> = cg_boco_normal_write(int fn, int B, int Z, int BC, int *NormalIndex, int NormalListFlag, DataType_t NormalDataType, void *NormalList);	- w m
<i>ier</i> = cg_nbocos(int fn, int B, int Z, int *nbocos);	r - m
<i>ier</i> = cg_boco_info(int fn, int B, int Z, int BC, char *boconame, BCTYPE_t *bocotype, PointSetType_t *ptset_type, int *npnts, int *NormalIndex, int *NormalListFlag, DataType_t *NormalDataType, int *ndataset);	r - m
<i>ier</i> = cg_boco_read(int fn, int B, int Z, int BC, int *pnts, void *NormalList);	r - m
call cg_boco_write_f(fn, B, Z, boconame, bocotype, ptset_type, npnts, pnts, BC, ier)	- w m
call cg_boco_normal_write_f(fn, B, Z, BC, NormalIndex, NormalListFlag, NormalDataType, NormalList, ier)	- w m
call cg_nbocos_f(fn, B, Z, nbocos, ier)	r - m
call cg_boco_info_f(fn, B, Z, BC, boconame, bocotype, ptset_type, npnts, NormalIndex, NormalListFlag, NormalDataType, ndataset, ier)	r - m
call cg_boco_read_f(fn, B, Z, BC, pnts, NormalList, ier)	r - m

Input/Output

fn	CGNS file index number. (Input)
B	Base index number, where $1 \leq B \leq \text{nbases}$. (Input)
Z	Zone index number, where $1 \leq Z \leq \text{nzones}$. (Input)
BC	Boundary condition index number, where $1 \leq BC \leq \text{nbocos}$. (Input for cg_boco_normal_write, cg_boco_info, cg_boco_read; output for cg_boco_write)
nbocos	Number of boundary conditions in zone Z. (Output)
boconame	Name of the boundary condition. (Input for cg_boco_write; output for cg_boco_info)

bocotype	Type of boundary condition defined. See the eligible types for <code>BCType_t</code> in Section 2.4 . Note that if <code>bocotype</code> is <code>FamilySpecified</code> the boundary condition type is being specified for the family to which the boundary belongs. The boundary condition type for the family may be read and written using <code>cg_fambc_read</code> and <code>cg_fambc_write</code> , as described in Section 16.3 . (Input for <code>cg_boco_write</code> ; output for <code>cg_boco_info</code>)										
ptset_type	<p>The extent of the boundary condition may be defined using a range of points or elements, or using a discrete list of all points or elements at which the boundary condition is applied. Depending on the method used, the possible values for <code>ptset_type</code> are:</p> <table> <tr> <th><code>ptset_type</code></th><th><i>Method</i></th></tr> <tr> <td><code>PointRange</code></td><td>Range of points or elements</td></tr> <tr> <td><code>PointList</code></td><td>List of points or elements</td></tr> <tr> <td><code>ElementRange</code></td><td>Range of elements</td></tr> <tr> <td><code>ElementRList</code></td><td>List of elements</td></tr> </table> <p>Note that when <code>ptset_type</code> is <code>ElementRange</code> or <code>ElementList</code>, the <code>pnts</code> values (see below) are assumed to be element indices. When <code>ptset_type</code> is <code>PointRange</code> or <code>PointList</code>, the choice of point or element indices is determined by <code>GridLocation_t</code> under the <code>BC_t</code> node. The value of <code>GridLocation_t</code> must be read or written by first using <code>cg_goto</code> to access the <code>BC_t</code> node, then using <code>cg_gridlocation_read</code> or <code>cg_gridlocation_write</code>. (Input for <code>cg_boco_write</code>; output for <code>cg_boco_info</code>)</p>	<code>ptset_type</code>	<i>Method</i>	<code>PointRange</code>	Range of points or elements	<code>PointList</code>	List of points or elements	<code>ElementRange</code>	Range of elements	<code>ElementRList</code>	List of elements
<code>ptset_type</code>	<i>Method</i>										
<code>PointRange</code>	Range of points or elements										
<code>PointList</code>	List of points or elements										
<code>ElementRange</code>	Range of elements										
<code>ElementRList</code>	List of elements										
npnts	Number of points or elements defining the boundary condition region. For a <code>ptset_type</code> of <code>PointRange</code> or <code>ElementRange</code> , <code>npnts</code> is always two. For a <code>ptset_type</code> of <code>PointList</code> or <code>ElementList</code> , <code>npnts</code> is the number of points or elements in the list. (Input for <code>cg_boco_write</code> ; output for <code>cg_boco_info</code>)										
pnts	Array of point or element indices defining the boundary condition region. There should be <code>npnts</code> values, each of dimension <code>IndexDimension</code> (i.e., 1 for unstructured grids, and 2 or 3 for structured grids with 2-D or 3-D elements, respectively). (Input for <code>cg_boco_write</code> ; output for <code>cg_boco_read</code>)										
NormalIndex	Index vector indicating the computational coordinate direction of the boundary condition patch normal. (Input for <code>cg_boco_normal_write</code> ; output for <code>cg_boco_info</code>)										
NormalListFlag	<p>For <code>cg_boco_normal_write</code>, <code>NormalListFlag</code> is a flag indicating if the normals are defined in <code>NormalList</code>; 1 if they are defined, 0 if they're not.</p> <p>For <code>cg_boco_info</code>, if the normals are defined in <code>NormalList</code>, <code>NormalListFlag</code> is the number of points in the patch times <code>phys_dim</code>, the number of coordinates required to define a vector in the field. If the normals are not defined in <code>NormalList</code>, <code>NormalListFlag</code> is 0. (Input for <code>cg_boco_normal_write</code>; output for <code>cg_boco_info</code>)</p>										
NormalDataType	Data type used in the definition of the normals. Admissible data types for the normals are <code>RealSingle</code> and <code>RealDouble</code> . (Input for <code>cg_boco_normal_write</code> ; output for <code>cg_boco_info</code>)										

NormalList	List of vectors normal to the boundary condition patch pointing into the interior of the zone. (<i>Input</i> for <code>cg_boco_normal_write</code> ; <i>output</i> for <code>cg_boco_read</code>)
ndataset	Number of boundary condition datasets for the current boundary condition. (<i>Output</i>)
ier	Error status. (<i>Output</i>)

14.2 Boundary Condition Datasets

Node: BCDataset_t

Functions	Modes
<i>ier</i> = <code>cg_dataset_write(int fn, int B, int Z, int BC, char *DatasetName, BCType_t BCType, int *Dset);</code>	- w m
<i>ier</i> = <code>cg_dataset_read(int fn, int B, int Z, int BC, int Dset, char *DatasetName, BCType_t *BCType, int *DirichletFlag, int *NeumannFlag);</code>	r - m
call <code>cg_dataset_write_f(fn, B, Z, BC, DatasetName, BCType, Dset, ier)</code>	- w m
call <code>cg_dataset_read_f(fn, B, Z, BC, Dset, DatasetName, BCType, DirichletFlag, NeumannFlag, ier)</code>	r - m

Input/Output

fn	CGNS file index number. (<i>Input</i>)
B	Base index number, where $1 \leq B \leq \text{nbases}$. (<i>Input</i>)
Z	Zone index number, where $1 \leq Z \leq \text{nzones}$. (<i>Input</i>)
BC	Boundary condition index number, where $1 \leq BC \leq \text{nbocos}$. (<i>Input</i>)
Dset	Dataset index number, where $1 \leq Dset \leq \text{ndataset}$. (<i>Input</i> for <code>cg_dataset_read</code> ; <i>output</i> for <code>cg_dataset_write</code>)
DatasetName	Name of dataset. (<i>Input</i> for <code>cg_dataset_write</code> ; <i>output</i> for <code>cg_dataset_read</code>)
BCType	Simple boundary condition type for the dataset. The supported types are listed in the table of “Simple Boundary Condition Types” in the SIDS manual, but note that <code>FamilySpecified</code> does not apply here. (<i>Input</i> for <code>cg_dataset_write</code> ; <i>output</i> for <code>cg_dataset_read</code>)
DirichletFlag	Flag indicating if the dataset contains Dirichlet data. (<i>Output</i>)
NeumannFlag	Flag indicating if the dataset contains Neumann data. (<i>Output</i>)
ier	Error status. (<i>Output</i>)

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The above functions are applicable to `BCDataSet_t` nodes that are children of `BC_t` nodes.

For `BCDataSet_t` nodes that are children of a `BC_t` node, after accessing a particular `BCDataSet_t` node using `cg_goto`, the Point Set functions described in [Section 9.2](#) may be used to read or write the locations at which the boundary conditions are to be applied. This is only applicable when the boundary conditions are to be applied at locations different from those used with `cg_boco_write` to define the boundary condition region (e.g., when the region is being defined by specification of vertices, but the boundary conditions are to be applied at face centers).

When writing point set data to a `BCDataSet_t` node, in addition to the specification of the indices using `cg_ptset_write`, the function `cg_gridlocation_write` must also be used to specify the location of the data with respect to the grid (e.g., `Vertex` or `FaceCenter`).

Functions	Modes
<code>ier = cg_bcdataset_write(char *DatasetName, BCType_t BCType, BCDataType_t BCDataType);</code>	- w m
<code>ier = cg_bcdataset_info(int *ndataset);</code>	
<code>ier = cg_bcdataset_read(int Dset, char *DatasetName, BCType_t *BCType, int *DirichletFlag, int *NeumannFlag);</code>	r - m
<code>call cg_bcdataset_write_f(DatasetName, BCType, BCDataType_t BCDataType, ier)</code>	- w m
<code>call cg_bcdataset_info_f(int *ndataset, ier)</code>	
<code>call cg_bcdataset_read_f(Dset, DatasetName, BCType, DirichletFlag, NeumannFlag, ier)</code>	r - m

Input/Output

Dset	Dataset index number, where $1 \leq \text{Dset} \leq \text{ndataset}$. (Input)
DatasetName	Name of dataset. (Input for <code>cg_bcdataset_write</code> ; output for <code>cg_bcdataset_read</code>)
BCType	Simple boundary condition type for the dataset. The supported types are listed in the table of “Simple Boundary Condition Types” in the SIDS manual, but note that <code>FamilySpecified</code> does not apply here. (Input for <code>cg_bcdataset_write</code> ; output for <code>cg_bcdataset_read</code>)
BCDataType	Type of boundary condition in the dataset (i.e., for a <code>BCData_t</code> child node). Admissible types are <code>Dirichlet</code> and <code>Neumann</code> . (Input)
ndataset	Number of <code>BCDataSet</code> nodes under the current <code>FamilyBC_t</code> node. (Output)
DirichletFlag	Flag indicating if the dataset contains Dirichlet data. (Output)
NeumannFlag	Flag indicating if the dataset contains Neumann data. (Output)
ier	Error status. (Output)

The above functions are applicable to `BCDataSet_t` nodes that are used to define boundary conditions for a CFD family, and thus are children of a `FamilyBC_t` node. The `FamilyBC_t` node must first be accessed using `cg_goto`.

The first time `cg_bcdataset_write` is called with a particular `DatasetName`, `BCType`, and `BCDataType`, a new `BCDataSet_t` node is created, with a child `BCData_t` node. Subsequent calls with the same `DatasetName` and `BCType` may be made to add additional `BCData_t` nodes, of type `BCDataType`, to the existing `BCDataSet_t` node.

14.3 Boundary Condition Data

Node: `BCData_t`

Functions	Modes
<code>ier = cg_bcddata_write(int fn, int B, int Z, int BC, int Dset, BCDataType_t BCDataType);</code>	- w m
call <code>cg_bcddata_write_f(fn, B, Z, BC, Dset, BCDataType, ier)</code>	- w m

Input/Output

<code>fn</code>	CGNS file index number. (Input)
<code>B</code>	Base index number, where $1 \leq B \leq \text{nbases}$. (Input)
<code>Z</code>	Zone index number, where $1 \leq Z \leq \text{nzones}$. (Input)
<code>BC</code>	Boundary condition index number, where $1 \leq BC \leq \text{nbocos}$. (Input)
<code>Dset</code>	Dataset index number, where $1 \leq Dset \leq \text{ndataset}$. (Input)
<code>BCDataType</code>	Type of boundary condition in the dataset. Admissible boundary condition types are <code>Dirichlet</code> and <code>Neumann</code> . (Input)
<code>ier</code>	Error status. (Output)

To write the boundary condition data itself, after creating the `BCData_t` node using the function `cg_bcddata_write`, use `cg_goto` to access the node, then `cg_array_write` to write the data. Note that when using `cg_goto` to access a `BCData_t` node, the node index should be specified as either `Dirichlet` or `Neumann`, depending on the type of boundary condition. See the description of `cg_goto` in [Section 4](#) for details.

14.4 Special Boundary Condition Properties

Node: BCProperty_t

Functions	Modes
<i>ier</i> = cg_bc_wallfunction_write(int fn, int B, int Z, int BC, WallFunctionType_t WallFunctionType);	- w m
<i>ier</i> = cg_bc_area_write(int fn, int B, int Z, int BC, AreaType_t AreaType, float SurfaceArea, char *RegionName);	- w m
<i>ier</i> = cg_bc_wallfunction_read(int fn, int B, int Z, int BC, WallFunctionType_t *WallFunctionType);	r - m
<i>ier</i> = cg_bc_area_read(int fn, int B, int Z, int BC, AreaType_t *AreaType, float *SurfaceArea, char *RegionName);	r - m
call cg_bc_wallfunction_write_f(fn, B, Z, BC, WallFunctionType, <i>ier</i>)	- w m
call cg_bc_area_write_f(fn, B, Z, BC, AreaType, SurfaceArea, RegionName, <i>ier</i>)	- w m
call cg_bc_wallfunction_read_f(fn, B, Z, BC, WallFunctionType, <i>ier</i>)	r - m
call cg_bc_area_read_f(fn, B, Z, BC, AreaType, SurfaceArea, RegionName, <i>ier</i>)	r - m

Input/Output

fn	CGNS file index number. (Input)
B	Base index number, where $1 \leq B \leq \text{nbases}$. (Input)
Z	Zone index number, where $1 \leq Z \leq \text{nzones}$. (Input)
BC	Boundary condition index number, where $1 \leq BC \leq \text{nbocos}$. (Input)
WallFunctionType	The wall function type. Valid types are Null, UserDefined, and Generic. (Input for cg_bc_wallfunction_write; output for cg_bc_wallfunction_read)
AreaType	The type of area. Valid types are Null, UserDefined, BleedArea, and CaptureArea. (Input for cg_bc_area_write; output for cg_bc_area_read)
SurfaceArea	The size of the area. (Input for cg_bc_area_write; output for cg_bc_area_read)
RegionName	The name of the region, 32 characters max. (Input for cg_bc_area_write; output for cg_bc_area_read)
ier	Error status. (Output)

The “write” functions will create the BCProperty_t node if it doesn’t already exist, then add the appropriate boundary condition property. Multiple boundary condition properties may be recorded under the same BCProperty_t node.

The “read” functions will return with *ier* = 2 = CG_NODE_NOT_FOUND if the requested boundary condition property, or the BCProperty_t node itself, doesn’t exist.

15 Equation Specification

15.1 Flow Equation Set

Node: FlowEquationSet_t

Functions	Modes
<i>ier</i> = cg_equationset_write(int EquationDimension);	- w m
<i>ier</i> = cg_equationset_read(int *EquationDimension, int *GoverningEquationsFlag, int *GasModelFlag, int *ViscosityModelFlag, int *ThermalConductModelFlag, int *TurbulenceClosureFlag, int *TurbulenceModelFlag);	r - m
<i>ier</i> = cg_equationset_chemistry_read(int *ThermalRelaxationFlag, int *ChemicalKineticsFlag);	r - m
<i>ier</i> = cg_equationset_elec magn_read(int *ElecFldModelFlag, int *MagnFldModelFlag, ConductivityModelFlag);	r - m
call cg_equationset_write_f(EquationDimension, <i>ier</i>)	- w m
call cg_equationset_read_f(EquationDimension, GoverningEquationsFlag, GasModelFlag, ViscosityModelFlag, ThermalConductModelFlag, TurbulenceClosureFlag, TurbulenceModelFlag, <i>ier</i>)	r - m
call cg_equationset_chemistry_read_f(ThermalRelaxationFlag, ChemicalKineticsFlag, <i>ier</i>)	r - m
call cg_equationset_elec magn_read_f(ElecFldModelFlag, MagnFldModelFlag, ConductivityModelFlag, <i>ier</i>)	r - m

Input/Output

EquationDimension	Dimensionality of the governing equations; it is the number of spatial variables describing the flow. (Input for cg_equationset_write; output for cg_equationset_info)
GoverningEquationsFlag	Flag indicating whether or not this FlowEquationSet_t node includes the definition of the governing equations; 0 if it doesn't, 1 if it does. (Output)
GasModelFlag	Flag indicating whether or not this FlowEquationSet_t node includes the definition of a gas model; 0 if it doesn't, 1 if it does. (Output)
ViscosityModelFlag	Flag indicating whether or not this FlowEquationSet_t node includes the definition of a viscosity model; 0 if it doesn't, 1 if it does. (Output)
ThermalConductModelFlag	Flag indicating whether or not this FlowEquationSet_t node includes the definition of a thermal conductivity model; 0 if it doesn't, 1 if it does. (Output)

TurbulenceClosureFlag	Flag indicating whether or not this FlowEquationSet_t node includes the definition of the turbulence closure; 0 if it doesn't, 1 if it does. (<i>Output</i>)
TurbulenceModelFlag	Flag indicating whether or not this FlowEquationSet_t node includes the definition of a turbulence model; 0 if it doesn't, 1 if it does. (<i>Output</i>)
ThermalRelaxationFlag	Flag indicating whether or not this FlowEquationSet_t node includes the definition of the thermal relaxation model; 0 if it doesn't, 1 if it does. (<i>Output</i>)
ChemicalKineticsFlag	Flag indicating whether or not this FlowEquationSet_t node includes the definition of a chemical kinetics model; 0 if it doesn't, 1 if it does. (<i>Output</i>)
ElecFldModelFlag	Flag indicating whether or not this FlowEquationSet_t node includes the definition of an electric field model for electromagnetic flows; 0 if it doesn't, 1 if it does. (<i>Output</i>)
MagnFldModelFlag	Flag indicating whether or not this FlowEquationSet_t node includes the definition of a magnetic field model for electromagnetic flows; 0 if it doesn't, 1 if it does. (<i>Output</i>)
ConductivityModelFlag	Flag indicating whether or not this FlowEquationSet_t node includes the definition of a conductivity model for electromagnetic flows; 0 if it doesn't, 1 if it does. (<i>Output</i>)
ier	Error status. (<i>Output</i>)

15.2 Governing Equations

Node: GoverningEquations_t

Functions	Modes
<i>ier</i> = cg_governing_write(GoverningEquationsType_t Equationstype);	- w m
<i>ier</i> = cg_governing_read(GoverningEquationsType_t *EquationsType);	r - m
<i>ier</i> = cg_diffusion_write(int *diffusion_model);	- w m
<i>ier</i> = cg_diffusion_read(int *diffusion_model);	r - m
call cg_governing_write_f(EquationsType, <i>ier</i>)	- w m
call cg_governing_read_f(EquationsType, <i>ier</i>)	r - m
call cg_diffusion_write_f(diffusion_model, <i>ier</i>)	- w m
call cg_diffusion_read_f(diffusion_model, <i>ier</i>)	r - m

Input/Output

EquationsType	Type of governing equations. The admissible types are Null, UserDefined, FullPotential, Euler, NSLaminar, NSTurbulent, NSLaminarIncompressible, and NSTurbulentIncompressible. (<i>Input</i> for cg_governing_write; <i>output</i> for cg_governing_read)
---------------	--

`diffusion_model` Flags defining which diffusion terms are included in the governing equations. This is only applicable to the Navier-Stokes equations with structured grids. See the discussion of `GoverningEquations_t` in the [SIDS manual](#) for details. ([Input](#) for `cg_diffusion_write`; [output](#) for `cg_diffusion_read`)

`ier` Error status. ([Output](#))

15.3 Auxiliary Models

Nodes: `GasModel_t`, `ViscosityModel_t`, `ThermalConductivityModel_t`, `TurbulenceClosure_t`, `TurbulenceModel_t`, `ThermalRelaxationModel_t`, `ChemicalKineticsModel_t`, `EMElectricFieldModel_t`, `EMMagneticFieldModel_t`, `EMConductivityModel_t`

Functions	Modes
<code>ier = cg_model_write(char *ModelLabel, ModelType_t ModelType);</code>	- w m
<code>ier = cg_model_read(char *ModelLabel, ModelType_t *ModelType);</code>	r - m
<code>call cg_model_write_f(ModelLabel, ModelType, ier)</code>	- w m
<code>call cg_model_read_f(ModelLabel, ModelType, ier)</code>	r - m

[Input](#)/[Output](#)

`ModelLabel` The CGNS label for the model being defined. The models supported by CGNS are:

- `GasModel_t`
- `ViscosityModel_t`
- `ThermalConductivityModel_t`
- `TurbulenceClosure_t`
- `TurbulenceModel_t`
- `ThermalRelaxationModel_t`
- `ChemicalKineticsModel_t`
- `EMElectricFieldModel_t`
- `EMMagneticFieldModel_t`
- `EMConductivityModel_t`

([Input](#))

`ModelType` One of the model types (listed below) allowed for the `ModelLabel` selected. ([Input](#) for `cg_model_write`; [output](#) for `cg_model_read`)

`ier` Error status. ([Output](#))

The types allowed for the various models are:

<code>GasModel_t</code>	Null, UserDefined, Ideal, VanderWaals, CaloricallyPerfect, ThermallyPerfect, ConstantDensity, RedlichKwong
<code>ViscosityModel_t</code>	Null, UserDefined, Constant, PowerLaw, SutherlandLaw

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ThermalConductivityModel_t	Null, UserDefined, PowerLaw, SutherlandLaw, ConstantPrandtl
TurbulenceModel_t	Null, UserDefined, Algebraic_BaldwinLomax, Algebraic_CebeciSmith, HalfEquation_JohnsonKing, OneEquation_BaldwinBarth, OneEquation_SpalartAllmaras, TwoEquation_JonesLaunder, TwoEquation_MenterSST, TwoEquation_Wilcox
TurbulenceClosure_t	Null, UserDefined, EddyViscosity, ReynoldsStress, ReynoldsStressAlgebraic
ThermalRelaxationModel_t	Null, UserDefined, Frozen, ThermalEquilib, ThermalNonequilib
ChemicalKineticsModel_t	Null, UserDefined, Frozen, ChemicalEquilibCurveFit, ChemicalEquilibMinimization, ChemicalNonequilib
EMElectricFieldModel_t	Null, UserDefined, Constant, Frozen, Interpolated, Voltage
EMMagneticFieldModel_t	Null, UserDefined, Constant, Frozen, Interpolated
EMConductivityModel_t	Null, UserDefined, Constant, Frozen, Equilibrium_LinRessler, Chemistry_LinRessler

16 Families

16.1 Family Definition

Node: Family_t

Functions	Modes
<i>ier</i> = cg_family_write(int <i>fn</i> , int <i>B</i> , char * <i>FamilyName</i> , int * <i>Fam</i>);	- w m
<i>ier</i> = cg_nfamilies(int <i>fn</i> , int <i>B</i> , int * <i>nfamilies</i>);	r - m
<i>ier</i> = cg_family_read(int <i>fn</i> , int <i>B</i> , int <i>Fam</i> , char * <i>FamilyName</i> , int * <i>nFamBC</i> , int * <i>nGeo</i>);	r - m
call cg_family_write_f(<i>fn</i> , <i>B</i> , <i>FamilyName</i> , <i>Fam</i> , <i>ier</i>)	- w m
call cg_nfamilies_f(<i>fn</i> , <i>B</i> , <i>nfamilies</i> , <i>ier</i>)	r - m
call cg_family_read_f(<i>fn</i> , <i>B</i> , <i>Fam</i> , <i>FamilyName</i> , <i>nFamBC</i> , <i>nGeo</i> , <i>ier</i>)	r - m

Input/Output

<i>fn</i>	CGNS file index number. (<i>Input</i>)
<i>B</i>	Base index number, where $1 \leq B \leq \text{nbases}$. (<i>Input</i>)
<i>nfamilies</i>	Number of families in base <i>B</i> . (<i>Output</i>)
<i>Fam</i>	Family index number, where $1 \leq \text{Fam} \leq \text{nfamilies}$. (<i>Input</i> for cg_family_read; <i>output</i> for cg_family_write)
<i>FamilyName</i>	Name of the family. (<i>Input</i> for cg_family_write; <i>output</i> for cg_family_read)
<i>nFamBC</i>	Number of boundary conditions for this family. This should be either 0 or 1. (<i>Output</i>)
<i>nGeo</i>	Number of geometry references for this family. (<i>Output</i>)
<i>ier</i>	Error status. (<i>Output</i>)

16.2 Geometry Reference

Node: GeometryReference_t

Functions	Modes
<i>ier</i> = cg_geo_write(int fn, int B, int Fam, char *GeoName, char *FileName, char *CADSystem, int *G);	- w m
<i>ier</i> = cg_geo_read(int fn, int B, int Fam, int G, char *GeoName, char **FileName, char *CADSystem, int *nparts);	r - m
<i>ier</i> = cg_part_write(int fn, int B, int Fam, int G, char *PartName, int *P);	- w m
<i>ier</i> = cg_part_read(int fn, int B, int Fam, int G, int P, char *PartName);	r - m
call cg_geo_write_f(fn, B, Fam, GeoName, FileName, CADSystem, G, <i>ier</i>)	- w m
call cg_geo_read_f(fn, B, Fam, G, GeoName, FileName, CADSystem, nparts, <i>ier</i>)	r - m
call cg_part_write_f(fn, B, Fam, G, PartName, P, <i>ier</i>)	- w m
call cg_part_read_f(fn, B, Fam, G, P, PartName, <i>ier</i>)	r - m

Input/Output

fn	CGNS file index number. (Input)
B	Base index number, where $1 \leq B \leq \text{nbases}$. (Input)
Fam	Family index number, where $1 \leq \text{Fam} \leq \text{nfamilies}$. (Input)
G	Geometry reference index number, where $1 \leq G \leq \text{nGeo}$. (Input for cg_geo_read, cg_part_write, cg_part_read; output for cg_geo_write)
P	Geometry entity index number, where $1 \leq P \leq \text{nparts}$. (Input for cg_part_read; output for cg_part_write)
GeoName	Name of GeometryReference_t node. (Input for cg_geo_write; output for cg_geo_read)
FileName	Name of geometry file. (Input for cg_geo_write; output for cg_geo_read)
CADSystem	Geometry format. (Input for cg_geo_write; output for cg_geo_read)
nparts	Number of geometry entities. (Output)
PartName	Name of a geometry entity in the file FileName. (Input for cg_part_write; output for cg_part_read)
ier	Error status. (Output)

Note that with `cg_geo_read` the memory for the filename character string, `FileName`, will be allocated by the Mid-Level Library. The application code is responsible for releasing this memory when it is no longer needed by calling `cg_free(FileName)`, described in [Section 10.6](#).

16.3 Family Boundary Condition

Node: FamilyBC_t

Functions	Modes
<i>ier</i> = cg_fambc_write(int fn, int B, int Fam, char *FamBCName, BCType_t BCType, int *BC);	- w m
<i>ier</i> = cg_fambc_read(int fn, int B, int Fam, int BC, char *FamBCName, BCType_t *BCType);	r - m
call cg_fambc_write_f(fn, B, Fam, FamBCName, BCType, BC, <i>ier</i>)	- w m
call cg_fambc_read_f(fn, B, Fam, BC, FamBCName, BCType, <i>ier</i>)	r - m

Input/Output

fn	CGNS file index number. (Input)
B	Base index number, where $1 \leq B \leq \text{nbases}$. (Input)
Fam	Family index number, where $1 \leq \text{Fam} \leq \text{nfamilies}$. (Input)
BC	Family boundary condition index number. This must be equal to 1. (Input for cg_fambc_read; <i>output</i> for cg_fambc_write)
FamBCName	Name of the FamilyBC_t node. (Input for cg_fambc_write; <i>output</i> for cg_fambc_read)
BCType	Boundary condition type for the family. See the eligible types for BCType_t in Section 2.4. (Input for cg_fambc_write; <i>output</i> for cg_fambc_read)
ier	Error status. (<i>Output</i>)

16.4 Family Name

Node: FamilyName_t

Functions	Modes
<i>ier</i> = cg_famname_write(char *FamilyName);	- w m
<i>ier</i> = cg_famname_read(char *FamilyName);	r - m
call cg_famname_write_f(FamilyName, <i>ier</i>)	- w m
call cg_famname_read_f(FamilyName, <i>ier</i>)	r - m

Input/Output

FamilyName	Family name. (Input for cg_famname_write; <i>output</i> for cg_famname_read)
ier	Error status. (<i>Output</i>)

17 Time-Dependent Data

17.1 Base Iterative Data

Node: BaseIterativeData_t

Functions	Modes
<i>ier</i> = cg_biter_write(int fn, int B, char *BaseIterName, int Nsteps);	- w m
<i>ier</i> = cg_biter_read(int fn, int B, char *BaseIterName, int *Nsteps);	r - m
call cg_biter_write_f(fn, B, BaseIterName, Nsteps, <i>ier</i>)	- w m
call cg_biter_read_f(fn, B, BaseIterName, Nsteps, <i>ier</i>)	r - m

Input/Output

fn	CGNS file index number. (Input)
B	Base index number, where $1 \leq B \leq \text{nbases}$. (Input)
BaseIterName	Name of the BaseIterativeData_t node. (Input for cg_biter_write; <i>output</i> for cg_biter_read)
Nsteps	Number of time steps or iterations. (Input for cg_biter_write; <i>output</i> for cg_biter_read)
ier	Error status. (<i>Output</i>)

17.2 Zone Iterative Data

Node: ZoneIterativeData_t

Functions	Modes
<i>ier</i> = cg_ziter_write(int fn, int B, int Z, char *ZoneIterName);	- w m
<i>ier</i> = cg_ziter_read(int fn, int B, int Z, char *ZoneIterName);	r - m
call cg_ziter_write_f(fn, B, Z, ZoneIterName, <i>ier</i>)	- w m
call cg_ziter_read_f(fn, B, Z, ZoneIterName, <i>ier</i>)	r - m

Input/Output

fn	CGNS file index number. (Input)
B	Base index number, where $1 \leq B \leq \text{nbases}$. (Input)
Z	Family index number, where $1 \leq Z \leq \text{nzones}$. (Input)
ZoneIterName	Name of the ZoneIterativeData_t node. (Input for cg_ziter_write; <i>output</i> for cg_ziter_read)
ier	Error status. (<i>Output</i>)

17.3 Rigid Grid Motion

Node: RigidGridMotion_t

Functions	Modes
<pre> ier = cg_rigid_motion_write(int fn, int B, int Z, char *RigidGridMotionName, RigidGridMotionType_t RigidGridMotionType, int *R); ier = cg_n_rigid_motions(int fn, int B, int Z, int *n_rigid_motions); ier = cg_rigid_motion_read(int fn, int B, int Z, int R, char *RigidGridMotionName, RigidGridMotionType_t RigidGridMotionType); </pre>	<pre> - w m r - m r - m </pre>
<pre> call cg_rigid_motion_write_f(fn, B, Z, RigidGridMotionName, RigidGridMotionType, R, ier) call cg_n_rigid_motions_f(fn, B, Z, n_rigid_motions, ier) call cg_rigid_motion_read_f(fn, B, Z, R, RigidGridMotionName, RigidGridMotionType, ier) </pre>	<pre> - w m r - m r - m </pre>

Input/Output

fn	CGNS file index number. (Input)
B	Base index number, where $1 \leq B \leq \text{nbases}$. (Input)
Z	Family index number, where $1 \leq Z \leq \text{nzones}$. (Input)
RigidGridMotionName	Name of the RigidGridMotion_t node. (Input for cg_rigid_motion_write; output for cg_rigid_motion_read)
RigidGridMotionType	Type of rigid grid motion. The admissible types are Null, UserDefined, ConstantRate, and VariableRate. (Input for cg_rigid_motion_write; output for cg_rigid_motion_read)
n_rigid_motions	Number of RigidGridMotion_t nodes under zone Z. (Output)
R	Rigid rotation index number, where $1 \leq R \leq \text{n_rigid_motions}$. (Input for cg_rigid_motion_read; output for cg_rigid_motion_write)
ier	Error status. (Output)

17.4 Arbitrary Grid Motion

Node: ArbitraryGridMotion_t

Functions	Modes
<i>ier</i> = cg_arbitrary_motion_write(int fn, int B, int Z, char *ArbitraryGridMotionName, ArbitraryGridMotionType_t ArbitraryGridMotionType, int *A);	- w m
<i>ier</i> = cg_n_arbitrary_motions(int fn, int B, int Z, int *n_arbitrary_motions);	r - m
<i>ier</i> = cg_arbitrary_motion_read(int fn, int B, int Z, int A, char *ArbitraryGridMotionName, ArbitraryGridMotionType_t ArbitraryGridMotionType);	r - m
call cg_arbitrary_motion_write_f(fn, B, Z, ArbitraryGridMotionName, ArbitraryGridMotionType, A, <i>ier</i>)	- w m
call cg_n_arbitrary_motions_f(fn, B, Z, n_arbitrary_motions, <i>ier</i>)	r - m
call cg_arbitrary_motion_read_f(fn, B, Z, A, ArbitraryGridMotionName, ArbitraryGridMotionType, <i>ier</i>)	r - m

Input/Output

fn	CGNS file index number. (Input)
B	Base index number, where $1 \leq B \leq \text{nbases}$. (Input)
Z	Family index number, where $1 \leq Z \leq \text{nzones}$. (Input)
ArbitraryGridMotionName	Name of the ArbitraryGridMotion_t node. (Input for cg_arbitrary_motion_write; <i>output</i> for cg_arbitrary_motion_read)
ArbitraryGridMotionType	Type of arbitrary grid motion. The admissible types are Null, UserDefined, NonDeformingGrid, and DeformingGrid. (Input for cg_arbitrary_motion_write; <i>output</i> for cg_arbitrary_motion_read)
n_arbitrary_motions	Number of ArbitraryGridMotion_t nodes under zone Z. (<i>Output</i>)
A	Arbitrary grid motion index number, where $1 \leq A \leq \text{n_arbitrary_motions}$. (Input for cg_arbitrary_motion_read; <i>output</i> for cg_arbitrary_motion_write)
ier	Error status. (<i>Output</i>)

18 Links

Functions	Modes
<i>ier</i> = cg_link_write(char *nodename, char *filename, char *name_in_file);	- w m
<i>ier</i> = cg_is_link(int *path_length);	r - m
<i>ier</i> = cg_link_read(char **filename, char **link_path);	r - m
call cg_link_write_f(nodename, filename, name_in_file, <i>ier</i>)	- w m
call cg_is_link_f(path_length, <i>ier</i>)	r - m
call cg_link_read_f(filename, link_path, <i>ier</i>)	r - m

Input/Output

nodename	Name of the link node to create, e.g., GridCoordinates. (Input)
filename	Name of the linked file, or empty string if the link is within the same file. (Input for cg_link_write; output for cg_link_read)
name_in_file	Path name of the node which the link points to. This can be a simple or a compound name, e.g., Base/Zone 1/GridCoordinates. (Input)
path_length	Length of the path name of the linked node. The value 0 is returned if the node is not a link. (Output)
link_path	Path name of the node which the link points to. (Output)
ier	Error status. (Output)

Use cg_goto(_f), described in [Section 4](#), to position to a location in the file prior to calling these routines.

When using cg_link_write, the node being linked to does not have to exist when the link is created. However, when the link is used, an error will occur if the linked-to node does not exist.

Only nodes that support child nodes will support links.

It is assumed that the CGNS version for the file containing the link, as determined by the CGNSLibraryVersion_t node, is also applicable to filename, the file containing the linked node.

Memory is allocated by the library for the return values of the C function cg_link_read. This memory should be freed by the user when no longer needed by calling cg_free(filename) and cg_free(link_path), described in [Section 10.6](#).